CANCER OF THE RECTUM

MONOGRAPHS ON NEOPLASTIC DISEASE AT VARIOUS SITES

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A CLINICAL PROSPECT OF THE CANCER PROBLEM
By D W Smithers

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NEOPLASTIC DISEASE AT VARIOUS SITES

General Editor

D W SMITHERS M D F R C P F F R

VOLUME III

CANCER OF THE RECTUM

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GENERAL INTRODUCTION TO THE SERIES OF MONOGRAPHS ON NEOPLASTIC DISEASE AT VARIOUS SITES

THIS book is one of a series of monographs on neoplasms at individual sites The intention is to present a detailed clinical picture of the range of neoplastic disease taking place in one particular organ or tissue at a time The general scheme is to discuss for each site what is known of the factors leading to the development of neoplasia and the possibilities of prevention or postponement which arise from them to consider the pathology and natural history of the disease as a means to understanding its course and modes of spread and thus to have a more secure basis both for planning treatment and for judging its results, to examine the methods of diagnosis of the earliest manifestations or of the pre neoplastic changes occurring in the hope of learning to deal with these tumours more frequently and more effectively before they have ceased to be a local problem, and to assess the methods of treatment now available and their value alone or in combination so as to review what is being achieved and to see what more could reasonably be expected A good deal of variation in presentation has been allowed for, however because of the very different problems which arise from site to site and which themselves made this method of detailed particularization in the clinical discussion of neoplastic disease seem so desirable at the present time

Much has been written about cancer without clear definition of what is being discussed Many of the causative factors would seem to be organ- or tissue specific or at least local in their action The natural history of this group of diseases differs markedly from one site of origin to another even in some special cases when separated by no more than a few millimetres The diagnostic problems often relate more to other diseases involving the sites in question than to cancer as an ill defined disease entity The really effective treatments that are available are still local ones in the great majority of cases and even those which do have some beneficial effect upon the disseminated disease are mostly specific to site of origin A good deal more could now be done with present methods of treatment for patients with neoplastic disease if the best that is available was more generally applied and further progress still would result at many sites from earlier treatment

Vague generalizations about cancer are at present of little use to the individual patients suffering from the disease a specific particularization about neoplasms at a given site is often of immediate practical value and may point the way to a deeper understanding The detailed clinical approach to this great problem may be in danger of occupying rather less of our attention than it deserves because of a wishful expectation that some simple solution covering all sites of origin will one day be provided for us

INTRODUCTION

One of the chief difficulties in the study of neoplastic disease at in
sites is in obtaining sufficient clinical experience Although these dise
common, so many parts are involved and the patients are so widely dis
throughout the medical service that few doctors see many patie
tumours of one particular tissue or organ during their whole lifetime
a group of postgraduate teaching hospitals in London started a scheme
consultation and co operation in the treatment of patients with certain t
In this way they hoped to pool their experience and to acquire sufficient
material for detailed study This series of monographs is based on t
of this group of hospitals and has been made possible by the large
of patients with tumours at individual sites seen by members of th
concerned It is not intended that the material for these books sh
strictly confined to this hospital group however but that they should
wide clinical experience wherever it may be found and enlist exp
whenever it is available

A part of each monograph is concerned with mortality statistics
those readers who may be unfamiliar with demographic methods, a dis
of some of the basic principles involved is included A great deal
explanatory material will be found, by those reading successive volume
repeated from volume to volume, this is for the benefit of those reade
interested in diseases of one particular site rather than in neoplasia in
may read only one volume of the series

Both the co operating hospital scheme and the preparation of thi
of monographs have for long been of great personal interest to me an
extremely grateful to my colleagues in my own and in the other h
concerned for their unselfish and generous assistance I took my
Mr Charles Macmillan of Messrs E & S Livingstone Limited in 19
was met with enthusiasm and an immediate promise of help which ha
provided in abundance since that day His response has now led to the
lishment of this series made possible only by a great deal of hard work
part of many people over a period of years

Each resulting monograph in its final form appears through the
of an individual editor working within the general framework laid
I owe a personal debt of gratitude to each one of them for their forbe
enthusiasm and unstinted labour I am also deeply indebted, as they
the many contributors who have worked with us in our attempt to
our aim

D W SMITHER

PREFACE

THIS Monograph on Rectal Cancer, Vol III in the series was commenced in 1956 and completed at the end of 1959 Its completion has taken longer than anticipated because the eighteen contributors are all busy people with many other claims on their time Each is an acknowledged authority on his particular subject but of course experts do not always agree and therefore the reader must expect to find some differences of opinion To allow for this some subjects such as the management of a colostomy and the avoidance of urinary complications after excision of the rectum have been dealt with by more than one author but overlapping has been avoided as much as possible

Most of the contributors have been engaged in the study and treatment of rectal cancer for many years and what they have written not only expresses their own mature individual opinions but taken as a whole, the book also provides a composite picture of the pathology and treatment of rectal cancer as understood at the present time

The last fifty years have witnessed an astonishing improvment in the general results of the surgical treatment of rectal cancer Perhaps in the future it may be said of the period now under review— There were giants living in those days !

I regard it as an honour and a privilege to have been entrusted with the task of editing this Monograph and wish to thank all the contributors for their help in the successful completion of this combined operation

CUTHBERT E DUKES

London 1960

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I am indebted to Messrs. Allen & Hanbury Ltd., Down Bros. Ltd., Genito Urinary Manufacturing Co. Ltd., and Vann Bros. Ltd. for the use of blocks illustrating their surgical instruments.

Also it is a pleasure to record acknowledgements for help in Section One and the Appendix to Miss Harley for invaluable help and constructive criticism, the Registrar General for access to the General Register Office Library, Somerset House, and the Somerset House Library Staff for able and willing assistance in tracing sources of international data.

Finally I am under a special debt of obligation to the Medical Committee of St. Mark's Hospital for permission to publish work based on the hospital records.

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SECTION ONE

THE MORTALITY FROM CANCER OF THE RECTUM IN ENGLAND AND WALES WITH DATA FROM OTHER COUNTRIES FOR COMPARISON

CHAPTER I

METHODS AND MATERIALS

R. A. M. CASE

Introduction

BEFORE we study the influence of sex, age and date on the death rates from cancer of the rectum in England and Wales, it may be well to consider how the data on which the rates are based have been collected and what sort of indices may be calculated from them.

In general, the raw materials used by vital statisticians are to be found in the details of birth, illness and death recorded for a nation. The completeness and accuracy with which such records are kept varies with the nature and complexity of the civilization of the country concerned. The primary motive in collecting and recording the data has not always been a concern for the public health, but often sprang from other aspects of civil and fiscal administration. Since nearly all, if not all, countries and communities have paid more attention to securing a complete and accurate recording of deaths than to recording all illness, it is not surprising that the most accurate and highly developed branch of vital statistics deals with death rates and could more properly be called mortal statistics. Strenuous efforts are at last being made to remedy this deficiency in the cancer field, but it will be a long time before the reporting of cases of disease is as complete as the recording of death.

Since this section is largely to be concerned with England and Wales, we may pass at once to a consideration of the raw materials that are available in these two countries and that are applicable to our purpose.

Population and Regions

An accurate estimate or enumeration of the population which comprises the community in question is our first need. Once every ten years, unless a major war renders it impracticable, the population is counted at a census. From this return the Registrar General can record the population distinguished by age and sex for England and Wales as a whole, for the administrative subdivisions and for the further subdivisions of occupation, industry and social class. The last two census years were 1931 and 1951.

With the passage of time these enumerated populations change, and the factors responsible for the change are birth, death and migration. The recording of births and deaths in England and Wales is virtually complete. Migration to and from these countries is partially recorded, but internal migration from area to area is poorly recorded.

From the census returns, and from the data relating to births, deaths and

migration, the Registrar General is able to prepare annual mid year estimates of the population, broken down by age and sex, for the whole of England and Wales with broader age groupings for the standard regions conurbations and aggregates of urban and rural areas outside the conurbations The smaller geographical subdivisions are merely provided with an estimate of the total population distinguished by sex but without any age breakdown

Death Registration

By law, all deaths must be notified to the local registrar of births and deaths within a short time of their occurrence The age sex address and cause of death of the deceased are entered on the certificate, thus allowing death to be classified by sex, age and geographical location For males and single females the last occupation is also recorded, but for married females the husband s occupation only is stated For this reason the occupational records relating to females are almost useless

The cause of death entered on the certificate is affected by various imponder able influences The diagnostic skill of the medical practitioner, current fashions in diagnosis, a desire not to offend the patient's relatives and the hospital facilities of the district may influence the entry In some cases the causes of death may be multiple, and a priority must be attached to one for classification purposes

The classification of disease is in itself a major problem, and the classifica tions used have had to be changed from time to time The one at present in use is the International Statistical Classification of Diseases, Injuries and Causes of Death Seventh Revision 1955 (World Health Organization 1957) This became effective for reports relating to 1958

Each year the Registrar General publishes his Annual Statistical Review of England and Wales This contains a return of all deaths distinguished by sex and by at present 607 disease classes in 5 year age groups, less detailed tables for the major geographical subdivisions and a statement of the number of deaths distinguished by sex but not by age for the minor geographical sub divisions

Indices

A series of indices can be derived from the population and number of deaths in each year by simple arithmetical methods, and it is wise to spend some time considering the nature of the statement made by each so that the appropriate one may be used in answering any particular question This is not really such a simple matter as it sounds and medical writings abound in confusion caused by neglecting this elementary precaution The indices that we may meet in this book are discussed in Appendix I (pp 281 and 285)

Some of these indices notably the crude death rate and the group of age standardized summarizing indices that includes the age standardized death rate the standardized mortality ratio (S M R) and the comparative mortality index (C M I) are extremely misleading when one is considering the biological

nature of a disease. (The reason for this is discussed in Appendix I (p. 285).)

Because of this I have avoided the use of summarizing indices as far as possible.

Cohort Analysis

Since the age-specific disease-specific death rates can be calculated for England and Wales in fairly small age groups (five year) from information published yearly, the variation of the intensity of the attack of killing diseases at different ages can be mapped fairly accurately. The rates for cancer of the rectum are shown in Tables I and II. Each vertical column of rates, distinguished by a date, is called a contemporary array of age specific death rates. Contemporary is used in the sense of referring to the *same date*, not in the sense of referring to the *present time*.

TABLE I

Contemporary Arrays of Age-specific Death Rates for Cancer of the Rectum (I.S.C. No. 154). England and Wales, 1911–55. Males

The data are arranged in a form suitable for cohort analysis

(From Case and Pearson 1955.)

Age	1911–15	1916–20	1921–25	1926–30	1931–35	1936–40	1941–45	1946–50	1951–55
0—	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
5—	0·000	△ 0·000	0·000	△ 0·000	△ 0·000	0·000	0·000	0·000	0·000
10—	0·000	△ 0·001	0·000	△ 0·000	△ 0·000	0·000	0·000	0·000	0·000
15—	△ 0·002	△ 0·002	△ 0·001	△ 0·002	△ 0·002	△ 0·002	0·001	0·001	0·001
20—	△ 0·004	△ 0·004	△ 0·003	△ 0·004	△ 0·004	△ 0·004	0·004	0·003	0·002
25—	△ 0·008	△ 0·007	△ 0·007	△ 0·008	△ 0·008	△ 0·009	0·009	0·006	0·004
30—	△ 0·016	△ 0·014	△ 0·015	△ 0·014	△ 0·016	△ 0·016	0·015	0·011	0·008
35—	0·025	0·026	0·023	0·021	0·026	0·023	0·028	0·020	0·017
40—	0·056	0·049	0·045	0·040	0·046	0·047	0·051	0·046	0·036
45—	0·101	0·101	0·101	0·092	0·092	0·082	0·088	0·082	0·064
50—	0·194	0·208	0·208	0·198	0·189	0·175	0·167	0·148	0·131
55—	0·357	0·368	0·387	0·375	0·363	0·350	0·331	0·287	0·234
60—	0·559	0·606	0·643	0·651	0·659	0·647	0·598	0·530	0·415
65—	0·776	0·844	0·933	1·018	1·040	1·027	1·056	0·878	0·701
70—	1·049	1·145	1·241	1·275	1·446	1·467	1·449	1·416	1·085
75—	1·245	1·216	1·388	1·627	1·642	1·803	1·808	1·795	1·639
80—	1·068	1·056	1·378	1·483	1·655	1·791	1·712	1·921	1·976
85+	0·887	0·869	1·070	1·377	1·358	1·604	1·303	1·616	1·924
All ages	0·096	0·109	0·127	0·144	0·162	0·176	0·185	0·181	0·158

Age specific death rates per thousand living per year.
Based on figures including non-civilians.
△ = Interpolated rate.

TABLE II

Contemporary Arrays of Age specific Death Rates for Cancer of the Rectum (I S C No 154) England and Wales 1911–55 **Females**

The data are arranged in a form suitable for cohort analysis

(From Case and Pearson 1955)

Age	*1911–15*	*1916–20*	*1921–25*	*1926–30*	*1931–35*	*1936–40*	*1941–45*	*1946–50*	*1951–55*
0—	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
5—	Δ 0 000	Δ 0 000	Δ 0 000	Δ 0 000	Δ 0 000	Δ 0 000	0 000	0 000	0 000
10—	Δ 0 000	Δ 0 000	Δ 0 000	Δ 0 000	Δ 0 000	Δ 0 000	0 000	0 000	0 000
15—	Δ 0 001	Δ 0 001	Δ 0 001	Δ 0 001	Δ 0 001	Δ 0 001	0 001	0 000	0 000
20—	Δ 0 003	Δ 0 002	Δ 0 003	Δ 0 004	Δ 0 003	Δ 0 003	0 003	0 002	0 002
25—	Δ 0 007	Δ 0 006	Δ 0 007	Δ 0 008	Δ 0 007	Δ 0 007	0 007	0 004	0 003
30—	Δ 0 014	Δ 0 013	Δ 0 012	Δ 0 013	Δ 0 014	Δ 0 013	0 013	0 013	0 009
35—	0 026	0 027	0 023	0 021	0 023	0 025	0 024	0 020	0 015
40—	0 048	0 049	0 049	0 041	0 042	0 040	0 042	0 033	0 035
45—	0 089	0 084	0 082	0 072	0 071	0 071	0 076	0 070	0 056
50—	0 144	0 151	0 135	0 121	0 110	0 126	0 120	0 112	0 096
55—	0 223	0 214	0 215	0 206	0 193	0 189	0 185	0 173	0 149
60—	0 331	0 330	0 334	0 317	0 312	0 278	0 285	0 259	0 236
65—	0 468	0 442	0 475	0 456	0 437	0 418	0 426	0 386	0 321
70—	0 624	0 625	0 614	0 622	0 653	0 631	0 603	0 580	0 480
75—	0 679	0 705	0 795	0 832	0 777	0 779	0 784	0 794	0 682
80—	0 605	0 660	0 807	0 847	0 857	0 847	0 880	0 965	0 900
85+	0 594	0 661	0 649	0 729	0 902	0 898	0 762	0 946	0 987
All ages	0 071	0 075	0 083	0 088	0 095	0 102	0 110	0 113	0 106

Age specific death rates per thousand living per year
Based on figures including non-civilians
Δ = Interpolated rate

If the groupings of ages and of dates are chosen in such a way that each age specific death rate is a mean value for an age date group that has equal sides (*i e 1 × 1 year 5 5 years 10 × 10 years*) then a series of rates is formed that enables us to follow the threat of death from various causes that has hung over people born in fairly narrow groups of calendar years and thus to differentiate the effect of the age of the individual from the effect of the date the individual was born, which fixes his relation to a changing social environment

This form of analysis formally called cohort analysis by Frost in an important posthumous paper in 1939 though used earlier by Cherry (1925) amongst others can give a useful picture of how a contemporary array of age specific death rates for a population in a particular calendar year is built up Although we have not sufficient data relating to the past to use cohort analysis for making detailed international comparisons of mortality the contemporary arrays of age specific mortality data shown in Figures 6–24 (pp 19–28) and in Appendix I Tables XXIV and XXV (pp 294 295) can more readily be comprehended if we make use of the insight into their origin that cohort analysis can give

For this reason the fundamental principles of cohort analysis as a background to the understanding of contemporary arrays of age specific death rates are discussed in Appendix I (pp 283–285)

CHAPTER II

MORTALITY FROM CANCER OF THE RECTUM IN ENGLAND AND WALES

R A M CASE

MORTALITY IN ENGLAND AND WALES AS A WHOLE

Numbers of Deaths from Cancer of the Rectum in England and Wales

DURING the last calendar year for which final figures have been published (1958) 3 132 males and 2 501 females were registered as dying of cancer of the rectum (Registrar General 1960)

The classification used (I S C No 154) is defined as —

Malignant neoplasm of rectum

Malignant neoplasm of anal canal (not anus)
rectosigmoid (junction)
rectum

Malignant neoplasm of the anus which accounts for very few deaths per year is classified (I S C Nos 190 5 191 5) with malignant neoplasms of the skin (World Health Organization 1957) and is not considered in this section

Cohort Analysis of Death Rates from Cancer of the Rectum in England and Wales

The age specific death rates for cancer of the rectum in England and Wales since 1911 are shown in Tables I and II (pp 3 4) The data are arranged in 5 year age groups and 5 year date groups (Case and Pearson 1955) These Tables provide sufficient data to enable us to use the method of cohort analysis mentioned and described in Appendix I (pp 283–285) to show how the present age specific death rate pattern has evolved

Figure 1 (p 6) shows the situation in a simplified form Four cohorts formed by quinary quinquennial grouping as described by Case (1956*a*) are used for the analysis The people in these cohorts were born around the central years 1871 1881 1891 and 1901 and they are chosen because —(*i*) The 1871 cohort attained the 80–84 age group in 1951–55 and thus became statistically extinct passing into the indeterminate age group called 85 and over for which no meaningful death rate can be computed (*ii*) A period of ten years between each cohort is convenient because it does not obscure the picture with too much detail as the consistent use of a 5 year interval would do (*iii*) The age group 50–54 is about the lowest at which analysis of the trend is profitable and this is the age group attained by the 1901 cohort in the last quinquennium for which we have data (1951–55) (The cohort lines in the picture drawn in this way correspond to the

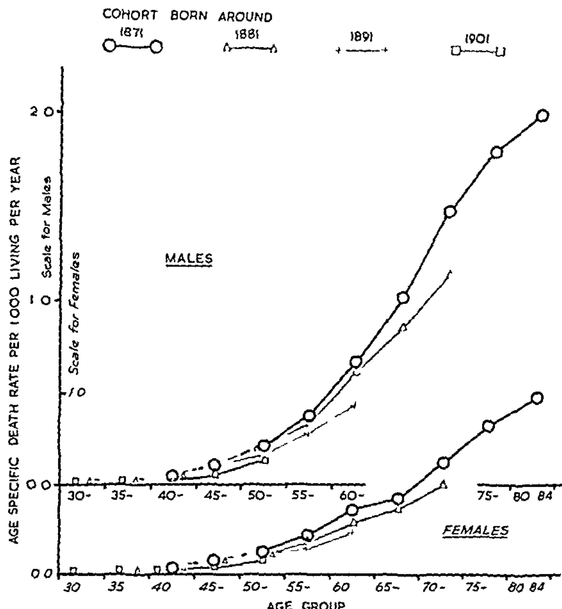


FIG 1

Cohort analysis of age specific death rates for cancer of the rectum England and Wales 1951-55 Males and females shown separately (After Case 1956b)

lines joining the tops of each series of chequered panels leading to the hypothetical 1951-55 contemporary age specific death rates at chosen ages shown in Figure 82 of Appendix I (p 285)

We can now see that for both males and females the death rate is initially very low but rises throughout the life span The rise becomes steeper after the age of 45 in both males and females

In addition to this rise in death rate with the age of the individual, a secular change of rates is shown for both sexes each successive cohort having lower rates at corresponding ages than earlier cohorts At the age of 50-54 the death rate for males born around 1901 is only 62 5 per cent of the rate for males of the same

age group born around 1871 and the corresponding figure for females is 74 1 per cent —a very considerable reduction in mortality rate

In contrast to the similarity of the *behaviour* of the male and female mortality rates in secular trend there is a marked difference in the *magnitude* of the rates at some ages those for males being the greater after the age of 40 Whilst it is a commonplace finding that males suffer a higher mortality age for age than females from most diseases from which both sexes may suffer (including cancer after the age of 50) this does not absolve us from considering nurture as well as nature as a possible reason for the difference

Interpretation of the Death Rates

It must be borne in mind as always when considering mortality data that the rates shown are based on recorded death rates As such they will reflect the effect of a complex of changing conditions that includes environment diagnosis treatment and social habits There is also reason to believe that a varying genetical pattern of the population might be another source of change although as yet we have no practical method of measuring this

It is not the function of this chapter to attempt to assess the influence of these factors in relation to the mortality changes that are shown A complete analysis of the relationship will probably never be possible but even a partial one would require a study of the social history of all these factors over the relevant period of time

Death Rates from Cancer of the Rectum in Relation to other Death Rates

Figures 2 and 3 (pp 8–11) have been drawn to put the death rates for cancer of the rectum into perspective They show the cohort picture for all causes of death for cancer of all sites and indicate the contribution of cancer of the rectum and of some other groups of sites In order to make some features of the mortality pattern of the later cohorts more apparent the scale of death rates has been altered for each cohort Because of this and because for each succeeding cohort the picture finishes progressively ten years earlier a strip from the preceding cohort or cohorts at the relevant age has been included in each picture

In each cohort the male death rate from all causes age for age is greater than the female death rate The male cancer mortality rate exceeds the female cancer mortality rate at all ages above 55 years The death rate from all causes is decreasing at all ages shown in the picture for females and at all ages under 60 for males The male 1891 cohort shows an increased mortality rate at age 60–64 when compared with the 1881 cohort though still favourable when compared with the 1871 cohort

The cancer mortality rate for males increases in each successive cohort whilst that for females decreases If the increase due to cancer of the lung is considered separately the residual cancer death rates decrease for both males and females

The death rate for cancer of the rectum can be seen to be decreasing in both sexes a finding shown also in Figure 1

Fig 2A

The age specific death rate picture for mortality in England and Wales by cohort analysis Males All causes of death and the contributions made by cancer at all sites cancer of the rectum and by some other main sites are shown

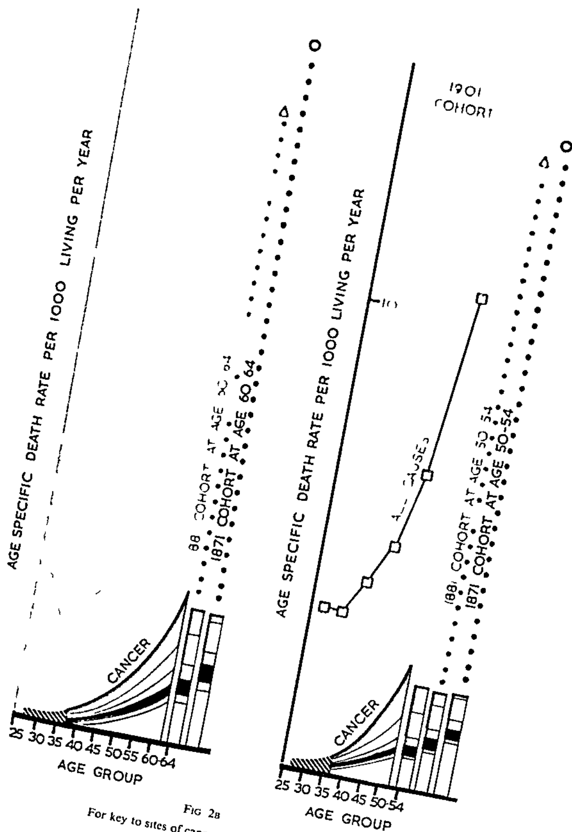


Fig 2B
For key to sites of cancer see Fig 3 overleaf

1871
COHORT

166

50
40
30
20
10

AGE SPECIFIC DEATH RATE PER 1000 LIVING PER YEAR

ALL CAUSES

CANCER

25 30 35-40-45-50-55- 60 65 70-75- 80-84

AGE GROUP

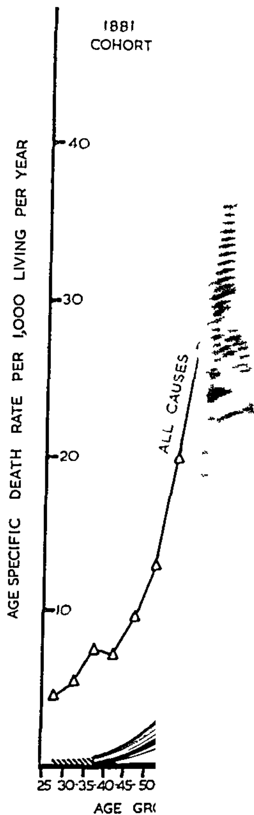
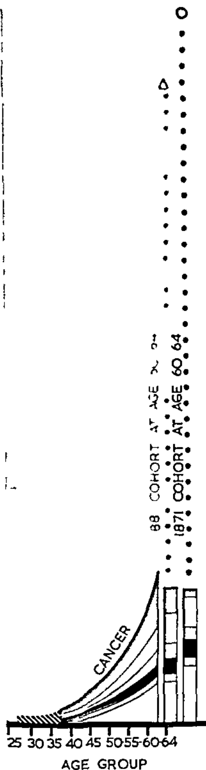


Fig 2A

The age specific death rate picture for mortality in England and Wales by cohort
All causes of death and the contributions made by cancer at all sites cancer of the
some other main sites are shown



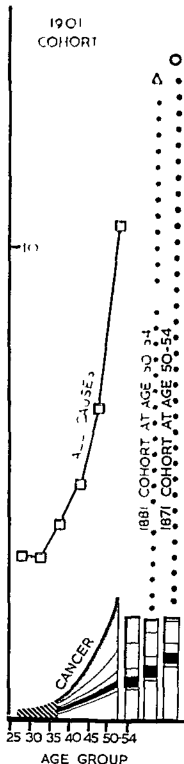
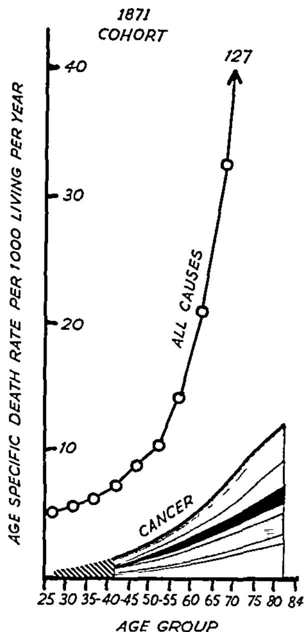
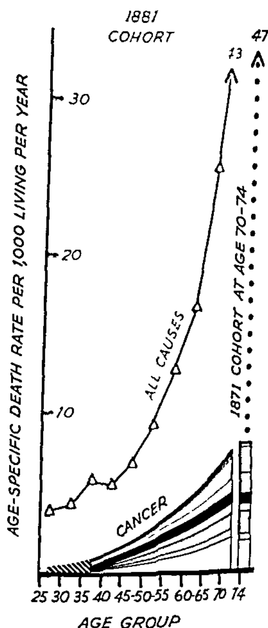


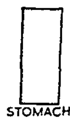
FIG 2B

For key to sites of cancer see Fig 3 overleaf









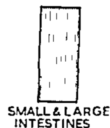
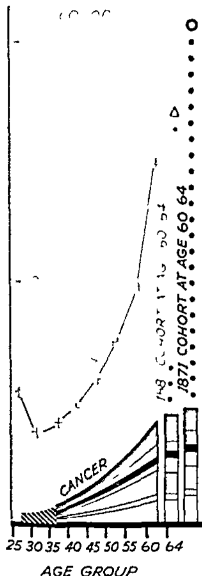
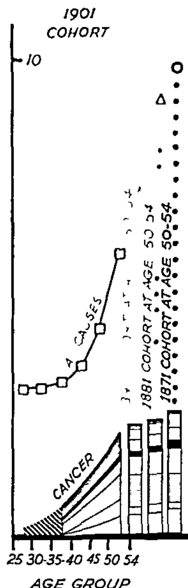




FIG 3A

The age specific death rate picture for mortality in England and Wales by cohort analysis Females. All causes of death and the contributions made by cancer at all sites cancer of the rectum and by some other main sites are shown





UTERUS
BREAST
OTHER
MALE
FEMALE
SEXUAL ORGANS

ALL SITES NOT OTHERWISE SPECIFIED

ALL SITES WHERE RATES ARE SUCH THAT DIFFERENTIATION IS IMPRACTICABLE

FIG 3B

VARIATIONS OF MORTALITY WITHIN ENGLAND AND WALES

The figures that we have been considering are the national rates Within any community however, there are factors at work which may prevent an even distribution of diseases It is usual to distinguish at least three types of variation that should be studied from this point of view —

(a) Seasonal effects
(b) Economic social and occupational effects
(c) Geographical effects These may be subdivided into urban-rural differentiation effects and local effects

When we come to subdivide the mortality data to study these variations our information is less detailed than the national annual returns and we are often forced to use indices which may indicate that variations exist but which do not help us to gain much insight into how they have evolved (see Appendix I pp 285–292)

Seasonal Effects

The Registrar General does not publish returns of monthly deaths from cancer of the rectum but includes them under the wider title *Malignant neo plasm of intestine including rectum* (International List Nos 152–154)

This broader group does not show any marked seasonal variation the deaths being evenly distributed throughout the year (Registrar General 1960) We may reasonably assume from this that deaths from cancer of the rectum do not show any pronounced seasonal variation partly because this would be likely to influence the published figures and partly because the broader classification would not have been used had any of the component sites differed greatly from the aggregate in behaviour

Economic Social and Occupational Effects

Economic and Social Effects

(i) Social Class

The commonly used stratifications are the Social Class and Socio economic groupings adopted by the Registrar General The current definitions are given by him in his Decennial Supplement (Registrar General 1958*a* Vol 1 p 12) The Social Class grouping is not entirely satisfactory as an index of economic effects since it is based on the social status of occupational groups and may in individual cases have little relation to income The Socio economic grouping *involving subdivision into thirteen categories is not suitable* when considering a comparatively small fraction of the total mortality since the number of deaths in each category is too small to yield reliable results

The Registrar General s (1958*a*) Social Class figures for cancer of the rec tum in males for the years 1949–53 show a slight but definite gradient the mor tality being highest in Social Class V (poorest) and lowest in Social Class I (richest) The mortality for married or single women shows no Social Class

trend. Widowed and divorced women are not discussed by the Registrar General in this context.

(ii) Marital Status

Calculations made from data for the years 1949–53 published by the Registrar General (1956, 1958*a*) show the mortality rates from cancer of the rectum to be much the same for single, married and widowed or divorced women.

Occupational Effects

Occupation is not generally regarded as being a factor in the aetiology of cancer of the rectum and there is nothing in the Registrar General's (1958*a*) Decennial Supplement on Occupational Mortality to contradict this view. Whether or not any occupational risks do in fact exist must, however, remain an open question. No effective occupational survey has so far been carried out and the methods perforce adopted in the Decennial Supplement fail to reveal even such well marked occupational risks as, for example, that of tumours of the bladder in the rubber industry (Case and Hosker, 1954).

Geographical Effects

Urban-rural Effects

The Registrar General's (1958*b*) most recent report on Area Mortality does not consider cancer of the rectum separately. It has therefore been necessary to examine data relating to the decennium 1921–30 (published by the Registrar General, 1952) to determine whether there is an urban-rural difference. Table III, computed from these data, shows that there is a well marked tendency for the mortality to be higher in both males and females in urban districts.

TABLE III

The Effect of Urbanization on the Mortality from Cancer of the Rectum England and Wales, 1921–30

(Calculated from Registrar General's (1952) data.)

District		*Standardized Mortality Ratios*	
		Males	*Females*
1	London	109.8	117.9
2	County Boroughs	103.9	102.5
3	Other Urban Districts	97.3	97.6
4	Rural Districts	94.5	90.6
5	All Urban Districts (1+2+3)	101.8	102.7
	England and Wales	100.0	100.0

CANCER OF RECTUM 1921 - 30

Males Ages 25 to 65

Actual mortality per cent of that expected from the distribution of population by age and class of district

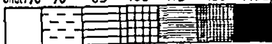


Counties including *County Boroughs*

Fig 4

Regional variations in mortality from cancer of the rectum 1921-30 Males (From Stocks 1936)

CANCER OF RECTUM 1921 - 30
Females Ages 25 and over
Actual mortality per cent of that expected from the distribution of population by age and class of district



Counties including County Boroughs

Fig 5

Regional variations in mortality from cancer of the rectum 1921–30 Females (From Stocks 1939)

Local Effects

Because the Registrar General in his regional reports does not give information about deaths from cancer of the rectum as such we must again go back to the decade 1921–30 Stocks (1928, 1936 1937 1939, 1947, Stocks and Karn 1931) systematically explored regional differences in death rates from cancer at different sites in a series of important and exhaustive papers He drew maps to show the local fluctuations in certain cancer death rates for the years 1921–30 Figures 4 and 5 are reproductions of two of these for cancer of the rectum in males and females respectively

Of these maps Stocks writes (1939 p 321) —

> The distribution of rectal cancer of females agrees closely with that shown for males The counties with significantly high mortality lie to the east of a line drawn from Goole to Bristol and thence to Bournemouth, with the possible exception of Staffordshire whilst Wales and the north and south west of England have low rates with the doubtful exceptions of Flint Pembroke and Westmorland

At present there seems to be no satisfactory explanation of these local variations in the mortality from rectal cancer

Morbidity Surveys (England and Wales)

We hope that in the future a considerable increase in our knowledge of cancer will accrue from studies of morbidity and prevalence Stocks (1958) has recently completed an excellent example of such a study relating to North Wales

Cancer Registration schemes at either national or regional level are at present being enthusiastically pressed The Registrar General (1958*c*) gives the most recent report on the Cancer Registration scheme in England and Wales

Nevertheless we have not yet achieved a sufficiently complete system of recording cases of cancer to allow morbidity rates to be calculated with anything like the precision of mortality rates For this reason we have not discussed morbidity This does not imply that the data already collected are not extremely valuable in other types of statistical studies such as the assessment of treatment which are outside the scope of this chapter

Conclusions

England and Wales

Cohort analysis of the mortality from cancer of the rectum in England Wales as a whole has shown that for both males and females the rate is very low until the fourth decade and that thereafter it rises throughout the life span The male death rate from rectal cancer age for age is higher than the female rate

In addition to this change with age a marked secular decrease of death rate has been demonstrated in both males and females

Other fluctuations of rectal cancer death rates are found These include a social class gradient amongst males an urban-rural differentiation in both sexes and a geographical variation within England and Wales males and females showing a similar pattern of mortality

CHAPTER III

COMPARISON OF MORTALITY IN SELECTED COUNTRIES

R A M CASE

THE mortality patterns for cancer of the rectum in seventeen countries in addition to England and Wales are shown in Figures 6–24 drawn from the contemporary arrays of age specific death rates for 1951–55 In the case of the United States of America, the white and non white populations have been treated separately The detailed tables on which these Figures are based together with an account of sources of data, method of calculation and the basis for the selection of the countries considered will be found in Appendix I (p 293)

The series of diagrams and the Appendix Tables should be considered in the light of cohort analysis as described in Appendix I (pp 283–5) and should not be regarded as a series of rates expressing solely the effect of the age of the individuals in the population

Study of these data reveals that in nearly all the countries considered males show a higher death rate from cancer of the rectum than females at ages over 50 below that age the male and female rates are nearly equal or the female rate is the higher

When we come to consider the magnitude of the rates the countries may be roughly divided into three groups and this division holds good at most ages and for both males and females —

(1) Those showing high rates Denmark the Netherlands New Zealand and the countries of the United Kingdom

(2) Those showing low rates Italy Japan and the non white population of the United States of America

(3) An intermediate group comprising the other countries considered here

The data are presented for reference purposes, no satisfactory explanation of the variations from country to country has yet been found

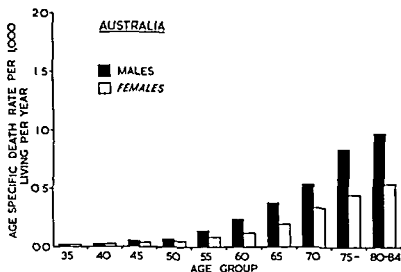


Fig 6

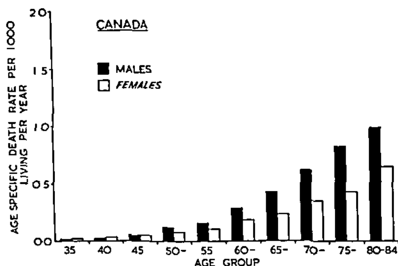


Fig 7

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

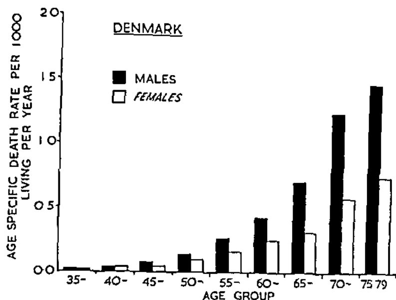


Fig 8

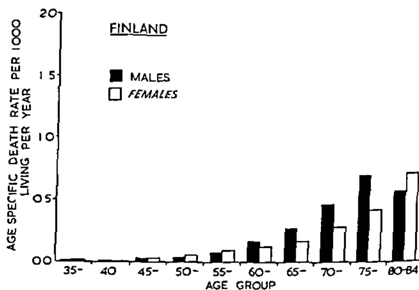


Fig 9

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951-55 Males and females shown separately

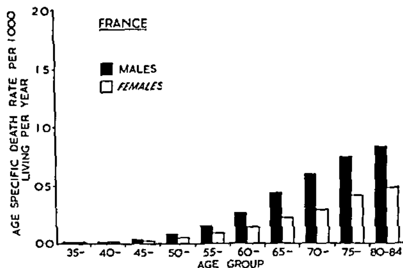


Fig 10

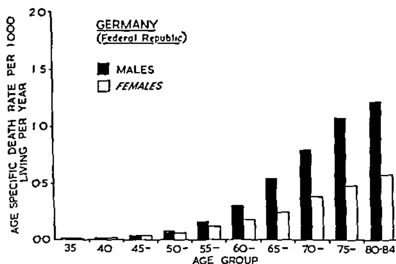


Fig 11

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

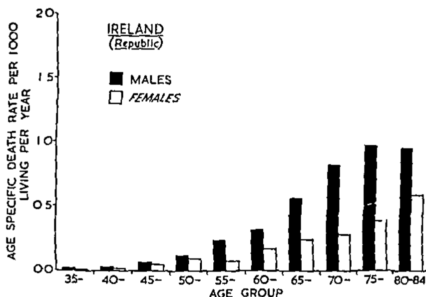


FIG 12

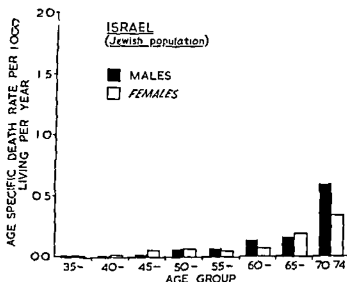


FIG 13

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951-55 Males and females shown separately

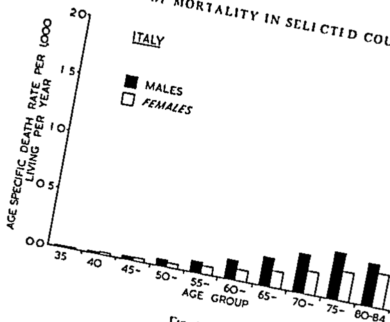


Fig 14

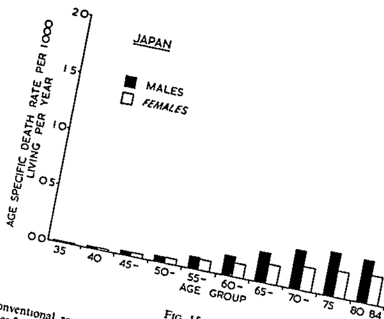


Fig 15

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951 55 Males and females shown separately

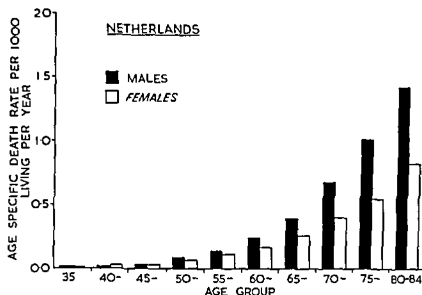


Fig 16

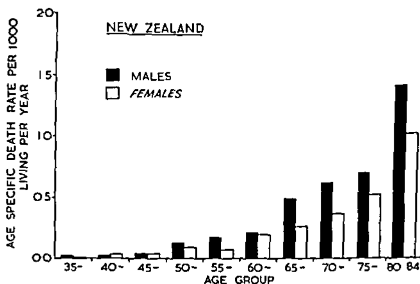


Fig 17

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

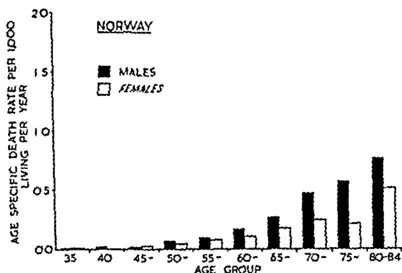


Fig 18

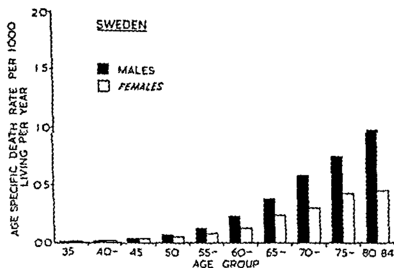


Fig 19

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

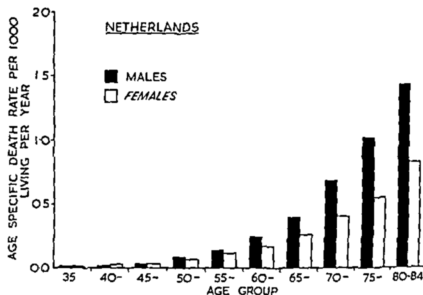


FIG 16

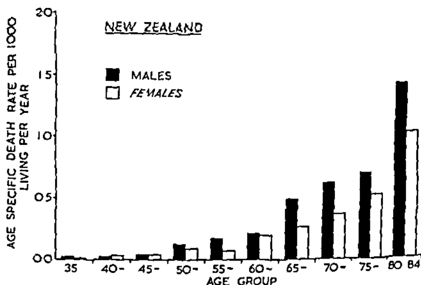


FIG 17

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951-55 Males and females shown separately

COMPARISON OF MORTALITY IN SELECTED COUNTRIES

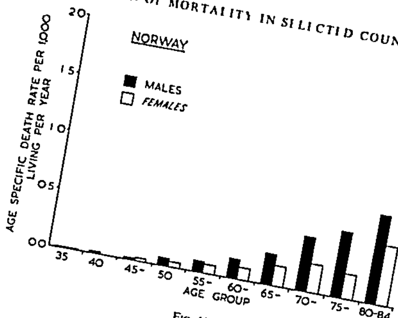


FIG 18

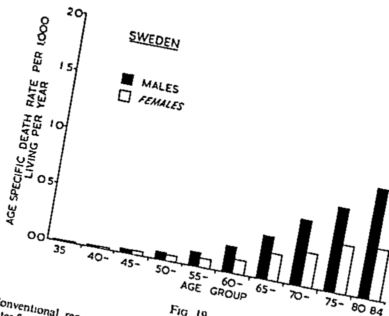


FIG 19

Conventional representation of contemporary arrays of age specific death rates from carcer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

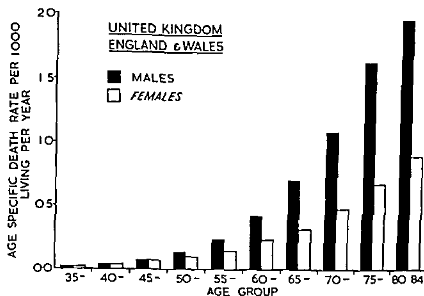


FIG 20

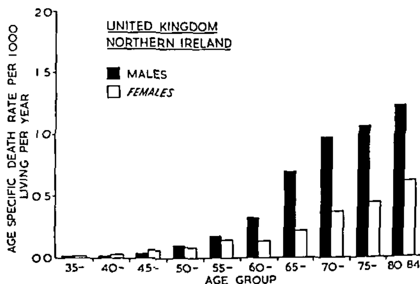


FIG 21

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

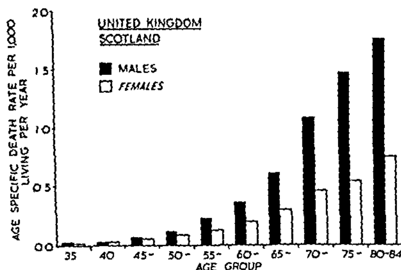


FIG 22

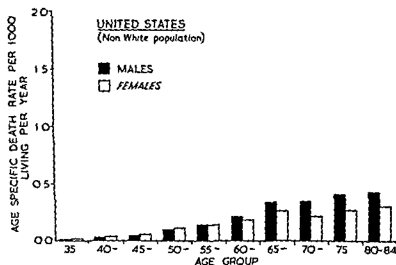


FIG 23

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951–55 Males and females shown separately

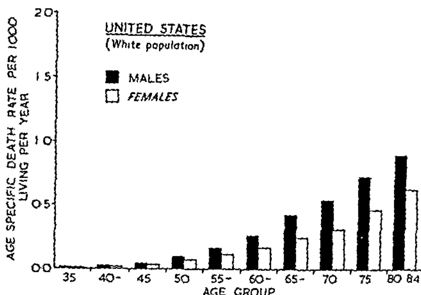


FIG 24

Conventional representation of contemporary arrays of age specific death rates from cancer of the rectum (I S C No 154) for various countries 1951 55 Males and females shown separately

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SECTION TWO

PREDISPOSING FACTORS AND CONTROL OF DEVELOPMENT OF RECTAL CANCER

CHAPTER IV

REFLECTIONS ON THE CAUSATION AND CONTROL OF RECTAL CANCER

CUTHBERT E DUKES

IN this introductory chapter the causation and possible control of rectal cancer will be discussed but because of the paucity of our knowledge regarding etiology the word reflections has been included in the title to warn the reader that he may expect opinions rather than established facts! It will be noticed that Causation and Control are linked together but no explanation or apology is needed for this Experience in other varieties of human cancer has shown that cancer control seldom becomes more than an unsubstantial dream until some thing definite has been learnt about etiology but as soon as even a little know ledge concerning causation has been acquired the possibilities of cancer control quickly begin to take shape Rectal cancer following familial polyposis provides a good example of this because a better understanding of the etiology of this form of cancer is already leading to some measure of control

I THE ETIOLOGY OF RECTAL CANCER

Although very little is known concerning the etiology of rectal cancer in man two important facts have been established concerning intestinal cancer in animals * The first is that rectal cancer is rare in animals living under natural conditions and the second is that chemical and physical agents which are known to cause tumours in other organs of the body may do so in the intestinal tract of experimental animals (Dukes 1959)

This at once raises the question as to whether or not human cancer might be due to hitherto undetected chemical carcinogens ingested with food The possibility of intestinal cancer being related to air pollution also needs to be considered because extraneous material in the atmosphere may be swallowed and so reach the alimentary as well as the respiratory mucosa

The supposition that ingested chemical carcinogens may be partly to blame for alimentary malignancies has much to commend it on theoretical grounds In the small intestine such substances would be considerably diluted and hurried through the bowel quickly but in the large intestine they would be concentrated and lie in contact with the mucosa for long periods This accords with the observed relative frequency of cancer of the large intestine and small intestine

However before proceeding further it must be pointed out that the produc

* The subject of tumours of the large intestine of mammals other than man is dealt with more fully by Dr D C Roberts in Chapter V

C

tion of intestinal tumours in experimental animals can only be achieved by excessive quantities of carcinogens, bringing the subject more into the realms of toxicology rather than dietetics! But on the other hand we must remember also that the intestinal mucosa of animals could not be described as a delicate and sensitive instrument since it is known to respond only to rude and violent shocks It might therefore be argued that a chemical carcinogen which only produced tumours in animals *in excessive doses might be carcinogenic to the* more sensitive human mucosa in much smaller doses Also we must not forget to take account of the long latent incubation period which is so characteristic of human environmental cancer, whether of the skin of chimney sweeps or the respiratory mucosa of cigarette smokers

Finally, although there is at present no evidence that cancer of the colon or rectum is attributable to any carcinogen used in industry, the history of occupational cancer of the bladder reminds us that many years may elapse before the dangers of an industrial carcinogen are recognized or even suspected

It is important to have established the fact that cancer can be produced experimentally by carcinogenic agents and this leads next to the question as to whether or not human cancer of the colon and rectum might arise from carcinogenic agents present in food or produced from food and its residues by the action of digestive secretions or bacteria in the alimentary tract It has been suggested that the cooking or preparation of food might result in the production of chemical carcinogens, such as benzpyrene Peacock (1956) has pointed out that the vessels used for cooking may be of importance in this respect He found that cotton seed oil heated to 320° C in the presence of iron was more carcinogenic *than the same oil heated in glass vessels*

In addition to overheated fat other foods which have been suspected of containing carcinogenic hydrocarbons are smoked meat, the scorched crusts of roasted meat and even the crust of a well baked loaf of bread! To investigate these suspicions Schonbauer and Schmidt Überreiter *(1956)* collaborated *with a* skilled cook and found that the usual technics of baking and roasting various fats yielded temperatures no higher than 190°–205° C and that a temperature of 270° C was never exceeded They tested prepared foodstuffs by U V spectography but did not detect any carcinogenic constituents and none of the bought or prepared foodstuffs they investigated contained any of the known carcinogenic hydrocarbons

It has even been suggested that incomplete mastication or 'bolting of food or taking it too hot or too cold might tend to cause cancer but there is no evidence for this and anyhow such bad habits would be more likely to cause cancer of the stomach than of the intestine

Another bad habit *which might possibly be responsible for* intestinal cancer is the regular taking of purgative medicine and this was investigated by Boyd and Doll (1954) who compared the purgative history of patients diagnosed as having a gastro intestinal cancer with a control group suffering from diseases other than gastro intestinal and found a marked excess *of liquid paraffin* medication amongst patients with gastro intestinal cancer They pointed out however that since the period 1905–10 when the medicinal use of liquid paraffin

was first introduced at all extensively, there has been no important increase in the mortality from cancer of the stomach or large bowel Furthermore liquid paraffin is used more commonly by women yet the mortality from cancer of the large bowel is greater in men

The possible carcinogenic action of chemical preservatives and colouring agents in food has attracted attention A rapidly growing number and variety of non nutritive substances have been introduced during recent decades into foodstuffs intended for general human consumption through the use of modern methods of food production and processing Some of these chemicals are intentionally added to foods while others are employed for different purposes and remain unintentionally as residues

Observations made during recent years have demonstrated that chemicals similar to those introduced into foodstuffs may possess carcinogenic properties when injected into animals but it cannot be assumed that chemical substances which induce tumours in one species of animals by one route would produce tumours by other routes in other species of animals

All that can be said at present is that the possibility that intestinal cancer may result from the addition of chemicals to food has to be kept in mind though so far there is no evidence that it is to be attributed to this cause Here is a field in which the new science of geographical pathology may help us in the future because food habits vary so greatly in different parts of the world Information concerning the geographical distribution of colon and rectal cancer will also settle the question as to whether or not infection with intestinal parasites such as Schistosoma mansoni predisposes in any way to intestinal cancer

The last factor in the etiology of rectal cancer and the only one of which we can speak with confidence is heredity The most striking example of this is familial polyposis of the colon a hereditary disease transmitted in accordance with Mendelian laws as if by a dominant gene and associated with a very high incidence of cancer of the colon and rectum (Dukes 1952) But I must point out that it is not cancer which is inherited in familial polyposis but only an excessive benign proliferation of the mucosal epithelium of the colon and rectum leading first to patches of hyperplasia and later to multiple adenomata Cancer is a secondary and in a sense an accidental phenomenon following an inherited precancerous lesion If a solitary adenomatous polyp may be precancerous how much more so multiple adenomata! At any rate this is the view which I take of the subject I do not think there is direct inheritance of cancer in polyposis families but only an indirect effect due to the inheritance of a lesion which predisposes to malignancy

Similar considerations apply to acquired adenomatous polyps of the rectum and to chronic ulcerative colitis Both of these conditions sometimes run in families though the hereditary factor is of course far less pronounced than in familial polyposis They are both precancerous in the sense that they may often be followed by cancer But here again it is the precancerous lesion which is inherited not the cancer (Dukes 1958)

Evidence for a straightforward direct inheritance of cancer is not obtainable in the great majority of patients suffering from carcinoma of the rectum

but every now and then a family is encountered in which intestinal cancer is commoner than in the general population It cannot be denied that these may be due only to chance variations in distribution but it is also possible that they may be due to genetic imbalance leading in these families to a proneness to cancer of the rectum

In his recent book entitled *Biological Aspects of Cancer*, Julian Huxley (1958) points out that all large cross breeding populations, including man will contain genes affecting cancer-proneness both positively and negatively in various degrees The high incidence of colon and rectum cancer in some families might possibly be genetic in origin

However, we can console ourselves with the thought that an inherited proneness to cancer would tend to be eliminated in the course of time because whenever genetic differences exist, or come into being by mutation natural selection begins to operate The general effect of natural selection will tend to delay the onset of deleterious effects with a genetic basis as far as possible, because individuals with delayed onset will, on the average, be able to beget and rear more offspring By these means 'the manifestation of certain genetic defects may be *driven into the post reproductive period* (Huxley 1958)

It is not unlikely that in the remote past mutations towards cancer proneness have often occurred and gradually been eliminated by the slow passage of time through the agency of natural selection

2 Control of Rectal Cancer in Polyposis Families

The term 'Cancer Control when applied indiscriminately to all forms of cancer has met with some criticism because in many varieties of malignant disease effective control is at present nonexistent, but its meaning is clear when the term is used in a more restricted sense and applied only to cancers of accessible sites and to those for which prevention and treatment are possible It would be difficult to find a more promising field for the exercise of cancer control than a polyposis family, because both diagnosis and treatment are possible in the precancerous stage and because the results of surgical treatment are excellent (Dukes 1958)

So that we may see our problem in its true perspective let me first recall three features in the natural history of the disease which have a direct bearing on cancer control These are concerned with the manner of inheritance of polyposis the age at which diagnosis is possible and the risk of subsequent cancer

Inheritance of Polyposis

Familial polyposis is a hereditary disease which is transmitted according to Mendelian laws It follows the pattern of inheritance of a dominant gene and if one parent only is affected and in the heterozygous state, the chances are that only half the children will inherit the disease Those who inherit will transmit it to half their children eventually Those who do not inherit the disease will not transmit it In other words, this means that some siblings of polyposis patients

may be affected and others may not be that half the sons and daughters of an affected member are likely to inherit the disease but that polyposis will not develop in nephews and nieces of affected members if their own parents are not affected

This is good news When a disease such as polyposis affects more than two or three members of a family the unaffected members often assume that they too are all destined to become victims sooner or later It comes as a great relief to be told that this is not so, it is as if half the burden was lifted! Mendel would have been surprised to learn that 100 years later the results of his experiments on peas would be applied to polyposis and might bring relief from anxiety to half the members of a polyposis family!

Age at Which Diagnosis is Possible

Affected members of polyposis families appear to be normal at birth and often throughout childhood In fact there are rarely any symptoms of intestinal disease until the second decade of life Reliable data concerning the exact time of onset of symptoms cannot be obtained in all cases but in a group of 38 patients in which special inquiries were made I found that the average age at onset of symptoms was 21 years

A fact of especial importance in relation to cancer control is that often there are no symptoms until AFTER the polyps have developed There is therefore a preclinical or occult phase of the disease preceding the onset of all symptoms During this incubation period (so to speak) a diagnosis of polyposis may be made by sigmoidoscopic examination before there has been any clinical manifestation

Therefore, looking at this question from the point of view of cancer control it may be useful to distinguish three stages in the natural history of familial polyposis In the first stage which may last throughout childhood there are no signs or symptoms of the disease and sigmoidoscopic examination would not reveal any abnormality In the second stage which is very variable in duration, polyps are developing but have not yet caused symptoms This is the time for diagnosis by sigmoidoscopy In the third stage there are both signs and symptoms of the disease This is the time for close supervision because surgical treatment will soon be necessary

Risk of Subsequent Carcinoma

The great frequency with which cancer follows polyposis is well known and some authors have gone so far as to say that cancer of the colon or rectum will develop in all affected members if they live long enough Such a generalization as this may be justified when applied to what I have called the third stage of the disease when both the signs and symptoms of polyposis are present To stress the danger of subsequent cancer at this stage I will add that not only does cancer very frequently follow clinical polyposis, but it is also very insidious in its onset not at first giving rise to any characteristic or distinctive symptoms

Without wishing in any way to seem to detract from the danger of subse

quent cancer, I must, however point out that in some polyposis families sigmoidoscopic examination of siblings may lead to the discovery of affected members who remain in good health and free from all symptoms but who may *transmit polyposis to their children* It seems as if in some patients the polyps do not increase in size or numbers over a period of years, and although such asymptomatic affected members should be kept under observation the danger of malignancy is not as great as *in those with clinical manifestations of the disease*

The objective of cancer control in familial polyposis is the prevention of cancer of the colon and rectum and this can be achieved only by keeping close contact with all members of the family in which the disease has already developed or may develop later

Control of Polyposis Patients

It is generally agreed that for patients who require major surgery there are at present only two forms of treatment either excision of the whole large bowel and performance of permanent ileostomy or preservation of part of the rectum and anastomosis of the ileum to it Experience has shown that this second form of treatment consistently provides satisfactory rectal function but the first form usually is necessary for those patients who have a carcinoma of the rectum It also may be necessary for patients in whom the polyps are so numerous in the rectum that destruction of them all by diathermy would be likely to result in much scarring and subsequent stenosis

Preservation of the rectum by ileorectal anastomosis certainly involves the risk that a new carcinoma may form later in the remaining rectal segment, and in order to reduce the risk of this the patient must be kept under supervision for the rest of his life

Polyposis patients who have undergone ileorectal anastomosis are advised to report regularly at intervals of three to four months for the first five years, after which this interval may be lengthened to six to 12 months At each re examination the patient undergoes sigmoidoscopy and all parts of the mucosa of the remaining portion of the rectum are carefully examined, if fresh polyps have formed since the last attendance these are treated by fulguration

Control of Siblings in Polyposis Families

It is generally possible with tact and sympathy, to establish good relationships with the siblings of patients who have polyposis and to keep in touch with them without causing resentment or anxiety In fact most of them appreciate the interest taken in them and realize that it is to their advantage

After the initial examination and inquiries further contact with siblings is made through a patient or affected member of the family who comes to the hospital for follow up treatment

The Supervision of Children in Polyposis Families

It would of course be of scientific interest to perform sigmoidoscopy in all children in polyposis families annually to ascertain at what age the polyps appear but even if such frequent examinations were possible it is questionable

whether the measure would be justifiable ethically, because to bring young children to hospital for an annual examination certainly would give rise to much unnecessary anxiety Hence we have now given up the attempt to carry out sigmoidoscopy in children less than 12 years old unless they have symptoms, and we concentrate on members of the teenage group, that is to say those young people 13 to 19 years old, inclusive

While children are less than 13 years old or so contacts with parents provide all the information required If any signs or symptoms of polyposis were to develop in children in the pre teenage period our experience has been that this occurrence is reported by an affected member or relative and the child is brought for examination without delay The danger of losing contact with children begins in the age period 13 to 19 years because this is the time when they become more independent and tend to escape from the control of parents or guardians Yet this teenage period—13 to 19 years—is just the time in which polyposis is most likely to develop in those who have inherited it For this reason we now make an especial effort to establish direct contact with the children of affected members early in the teenage period and to invite each child personally to report for examination about the age of 13 or 14 years In place of the indirect and collective inquiries made at an earlier age the children are now addressed directly and individually a recognition of their new independent status which they appreciate and to which they generally respond This personal interview provides an opportunity for a thorough physical examination including sigmoidoscopy and also the search for other physical abnormalities such as sebaceous cysts and connective tissue tumours which are known to be associated with polyposis in some families

In conclusion it may be said without fear of contradiction that cancer control in polyposis families is well worth the time and energy involved Is has something to offer which is badly needed and gratefully accepted It results in a diminution in human anxiety and suffering and an increase in health and confidence

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SECTION THREE

THE PATHOLOGY OF RECTAL TUMOURS

CHAPTER V

TUMOURS OF THE LARGE INTESTINE OF MAMMALS OTHER THAN MAN

D C ROBERTS

TUMOURS OCCURRING NATURALLY IN ANIMALS

Occurrence

IN the year 1802 the Medical Committee of the Society for Investigating the Nature and Cure of Cancer circulated a set of 13 Queries The Queries were republished four years later together with 'Observations explanatory to their object (Baillie *et al* 1806)

Query No 10 read

Query 10th—Are brute creatures subject to any disease resembling cancer in the human body?

The explanatory observations stated that it was not known whether brute creatures were subject to cancer though some of their diseases have a very suspicious appearance but if they did so suffer inquiry should be made into what class was affected wild or domesticated the carnivorous or graminivorous those which did or those which did not chew the cud It was hoped that the information could be readily obtained as the treatment of their diseases has at length fallen under the care of scientific men

It was to be 100 years before the fact that cancer occurred throughout the animal kingdom was accepted though individual reports of tumours were published Although Crisp (1874) was able to refer to his large collection of tumours in domesticated animals at the turn of the century many authorities still regarded cancer as a disease peculiar to mankind or that it occurred rarely in animals living with man under conditions of civilization

From this time however papers were published based not on individual cases but on large series of animals Thus Sticker (1902) whose cases were collected mainly from the records of veterinary colleges in Germany referred to 1 217 domesticated animals with cancer the tumours being distributed through the various species as follows 332 horses 766 dogs 21 cats 78 cattle 8 sheep and 12 pigs Trotter (1906 1911) made a comprehensive analysis of 300 malignant neoplasms in bovines

The papers of Bashford and Murray (1904) and Murray (1908) did much to swing medical opinion to the belief that cancer occurs throughout the animal kingdom describing tumours not only in domesticated animals but also in birds amphibia and fishes

In 1913 Wolff published a compilation of data on tumours in dogs horses and bovines, and in the same year Martel listed 184 carcinomas found in 38,800 horses (the majority of them aged over 15 years) which had been slaughtered in the abattoirs of Paris, of these, 9 were in the intestine Crocker (1919) published the results of 3,000 autopsies performed at the University of Pennsylvania on a wide variety of animal species, and Feldman (1932) the first textbook devoted to neoplasms in domesticated animals, still regarded by many as the best in English

In 1936 Jackson reviewed the 600 tumours of domesticated animals which comprised the Onderstepoort Collection describing many in detail his critical comments both on the specimens and on problems of mammalian oncology are very valuable

A number of other texts have been published, notably that of Courteau (1935), Plummer (1948, 1951 and 1956) on tumours of domesticated animals in Canada Mulligan (1949) on 1,000 consecutive tumours of dogs in the United States of America Monlux *et al* (1956) on tumours in a large series of cattle, sheep and swine slaughtered at Denver, Colorado and Cotchin (1947–56) on tumours of dogs and cats in England and also (1956) a most valuable review of neoplasms of the domesticated mammals

For tumours in laboratory animals the reviews of Tamaschke (1955) and Guerin (1954) may be consulted, Fardeau (1931) has reviewed the tumours of the rabbit, and Warren and Gates (1941) those of the guinea pig *

Publications on tumours in captive wild mammals include those of Fox (1923) and Ratcliffe (1933) who lists the tumours occurring in animals dying at the Philadelphia Zoological Garden this list is extended to 1956 by Lombard and Witte (1959) The reports of the Pathologist on animals dying in the Society s gardens are published in the *Proceedings of the Zoological Society of London*, while the extensive bibliography of Halloran (1955) lists 305 tumours in a variety of species

Incidence

While tumours are found to be widely distributed throughout the animal kingdom and indeed are common in the older animals of some species (Steiner and Bengston 1951 have suggested that the economic loss due to tumours in food producing mammals in the United States of America exceeded $3 000 000 in 1949) all the series yet published have been based on highly selected material In most species (the dog is an exception) the age of the individual animals is not known and other factors such as the geographical location of the observer may bias the figures At the present time we can only say that a given tumour is very common common rare very rare or not reported (Innes 1958)

Cramer (1932) has considered the effect of the age of the animals concerned on the apparent incidence of tumours and illustrates his argument with figures obtained from Trotter showing how the apparent incidence of cancer in cattle slaughtered in Glasgow was raised from 1 in 2 400 animals in 1903 to 2 8 per

* See also Fischer & Kuhl (1958)

1 000 animals in 1904 by the presence in the latter series of a relatively small number of aged cows from Ireland

The overall incidence of tumours in various species of laboratory animals is not known The incidence of a given tumour may vary from strain to strain in a given species between colonies of the same strain in different laboratories and from time to time in a colony at a single laboratory It is, of course, essential for many purposes such as experiments on carcinogenesis, to know the tumours which occur naturally, and to this end samples should be set aside from time to time to reach the cancer age In addition an adequate number of control animals with each experiment will give an indication of the prevailing incidence at the time of the experiment The number and types of tumour occurring in any sample will be accurately known only if a full post mortem examination be carried out on each individual of the sample (it is not unknown, for example for the examiner to fail to open the caecum of a small laboratory animal yet this may be the only way to demonstrate an early tumour of the mucosa) and if an adequate number of samples of organs be taken for histological examination

TUMOURS OF THE LARGE INTESTINE

DOMESTICATED MAMMALS

Tumours of the large gut of mammals are rare, and in no species form a sufficiently large proportion of the tumours described in that species to be considered species characteristic (see Schlumberger 1957) On the subject of intestinal polyposis opinion is divided Wolff (1913) claiming precancerous polyposis adenomatosa one has seen many times in horses a precursor, as in man, of cancer and Balo and Korpassy (1935) believed that their failure to find cancers in cases of cattle with multiple intestinal polyps might be due to the short life of food animals On the other hand Courteau (1935) says Chez tous les mammiferes frequence moindre que chez l homme des tumeurs benignes et surtout malignes Jusqu ici on n a pas retrouve chez les animaux la polypose hereditaire du gros intestine dont le role est bien etabli chez l homme dans la genese des cancers La frequence de ceux ci meme chez les sujets jeunes parait donc propre a la pathologie humaine

In a review of the literature of tumours of the intestine in domesticated animals the bibliography of which is sadly incomplete Samso and Catenei (1952) found 24 primary malignant tumours of the large intestine These were as follows 12 carcinomas and 2 sarcomas of the colon one carcinoma and 2 sarcomas of the rectum of horses one carcinoma and one sarcoma of the colon 2 carcinomas and one sarcoma of the rectum of dogs, and one carcinoma of the colon and one sarcoma of the rectum in cattle

Horse

Olt (1900) described a single case The host was a fat 5 year old horse which had been treated for constipation A tumour was found per rectum and the

animal was killed Squamous stratified epithelium extended 26 cm from the anus and 15 cm from the anus the wall was thickened and stenosed by a squamous carcinoma Sticker (1902) described among 298 cases of cancer in horses, 4 tumours of the colon and one of the rectum, and Ehlers (1901–2) a single adeno carcinoma of the colon The incidence of intestinal tumours among 3 500 horses slaughtered at the abattoir at Dresden was recorded by Achilles (1907), 10 tumours were found in 7 animals 9 were sarcomas of the serosa muscularis or submucosa usually of the large bowel while only one was a carcinoma Rubarth (1934) reviewed the literature on gastro intestinal cancer and added an adenocarcinoma of the caecum, one of the small colon and an epidermoid cancer of the anus with metastasis to the regional lymph node

Petit (1905) recorded a calcifying adenomatous polypoid tumour of the rectum of a horse Stromal ossification was described by Lund (1925), Dirks (1925) and Schenke (1934) in a caecal carcinoma in a mare an adenocarcinoma of the caecum of a 13 year old gelding and in a carcinoma of an 18 to 20 year-old horse which had formed an entero anastamosis between the caecum and the colon respectively

A round cell sarcoma of the large intestine of a mare was reported by Ball and Anier (1927), a similar tumour by Ball and Lombard (1928) in the colon of a 19 year old mule while Salomon (1933) described multiple lymphangiomas on the small and the large intestine of a 20 year old mare

Ox

The oldest specimen of a tumour of the large intestine of an ox known to the author is in the Hunterian Collection at the Royal College of Surgeons It is a tumour of the rectum (No 1,265 Pathological Series 1st ed catalogue No 6654 I 3rd ed catalogue) and is described as a carcinoma

Trotter (1905–6, 1911) in his analysis of 300 cases of malignant tumours in cattle reports only a single tumour of the large bowel, a carcinoma of the rectum in an aged cow from Ireland whilst Schlegel (1925) describes a colloid carcinoma of the colon in a 14 year old cow

Adenomatous polyps were reported by Zwaenepoel (1904) in the large intestine of an old cow while Balo and Korpássy (1935) found adenomatous polyps in the region of the large intestine in 6 6 per cent of 300 slaughtered cattle They stated that polyps of the small intestine arising in Peyer s patches were much more common than polyps of the large gut and suggested that the failure to find cancerous change might be due to the short life of food animals

Sheep

Head (1953) reported an adenocarcinoma of the large intestine of a sheep but tumours of the large gut of sheep are rarely reported There is none mentioned in the series of Sticker (1902) Plummer (1956) or Monlux *et al* (1956) while the only ovine intestinal cancer in Jackson s survey is one of the small gut

Swine

The life of the domesticated pig is usually short, and no case of cancer in the large bowel is known to the author

Biester and Schwarte (1931) described adenomatous growths in the caecum and large colon of three pigs They believed these to be regenerative formations following destruction of mucosa, and were able to produce a similar condition by experimental injection of material from pigs with dysentery However in 1939 they described with Eveleth a fourth case apparently not caused by an infective agent Moynihan and Gwatkin (1941) described a similar condition in a pig the last 65 cm of the intestine being much thickened, the inner wall having a cauliflower appearance due to proliferation of the glands There was a heavy infestation with Ascaris lumbricoides in the first part of the small intestine but no history of infective enteritis Balo and Korpassy (1935) reported adenomatous polyps in the region of the large intestine in 6 per cent of 400 slaughtered pigs and Korpassy and Toboldi (1957) stated that these polyps occur with greater frequency among inbred pigs kept in large stocks than in pigs of various extractions bred by smallholders They discussed the possibility that the polyps might be induced by an agent of virus character, but were unable to prove this experimentally It is unlikely that these polypoid lesions of pigs are true neoplasms they appear to be regenerative in nature following some process which destroys the mucosa

Dog

de Meis and Parascandolo (1903) reported the operative removal of an annular carcinoma from the caecum of a dog Murray (1908) mentioned a columnar cell carcinoma of the rectum of a 15 year old male dog and three tumours of the anus an adenocarcinoma a malignant adenoma and a squamous cell carcinoma In 1,548 autopsies on dogs at the University of Pennsylvania Crocker (1919) found 27 tumours of which one was a carcinoma of the rectum Carcinoma of the rectum has also been described by Rubarth (1934), by Schlotthauer (1940) in a 9 to 10 year old male mongrel Airedale (both tumours had metastasized) and by Woodward (1941) in a 6 year old male Dachshund

Schlotthauer and Grindlay (1951) reported a carcinoma of the rectum of a 10 year old male Labrador which was treated by surgical removal of the rectum Unfortunately the dog suffered from post operative incontinence and was destroyed after 2 months at the request of the owner Überreiter (1955) found one tumour of the colon and 13 of the rectum in a series of 3 040 neoplasms Eight of the 13 rectal tumours were benign (4 adenomas 3 fibromas and one myoma) while 5 were malignant (2 carcinomas one fibrosarcoma and 2 round cell sarcomas) Krook (1956) described a carcinoma gelatinosum of the rectum in a 6 year old Irish setter bitch which had metastasized to lymph nodes and to the liver and an adenocarcinoma of the rectum in a 12 year old Alsatian bitch which had also metastasized to lymph nodes and to the liver

Feldman (1928) reported a malignant leiomyoma of the caecum in a 13 year old shepherd dog Cotchin (1954) finds the common malignant tumour of

the intestine of the dog to be a lymphosarcoma, and a tumour of this type which had metastasized was reported in the rectum of a champion male fox terrier by McCunn *et al* (1934)

In a series of over 4,000 tumours of dogs examined at the Royal Veterinary College since 1940, Cotchin (1959) found 14 per cent to be in the alimentary system, while tumours of the intestine formed just over 20 per cent of the alimentary tumours Of these 130 intestinal tumours, 82 were sarcomas and 21 (or possibly 22) were carcinomas It was possible in 15 cases out of the 21 accurately to describe the place of origin 3 were of the small intestine, 3 of the colon while 9 had arisen in the rectum

Cat

Nielsen and Holzworth (1953) state that the intestine of the cat is commonly involved in visceral lymphosarcoma, the small intestine being more frequently affected than the large Joest (1907) reported a carcinoma of the colon in a cat and Rubarth (1934) stromal bone formation in a caecal tumour, while Cotchin (1959) in a series of over 550 tumours of cats examined at the Royal Veterinary College since 1940 found 151 malignant tumours of the alimentary system, of which 53 were of the intestine Of these, 42 were sarcomas and 11 carcinomas there being only one carcinoma of the large bowel which was in the caecum

Laboratory Mammals

Rabbit

Tumours of the large gut of the rabbit appear to be very rare Bell and Henrici (1916) reviewed the literature from 1898, found 35 tumours and added two renal tumours None of the 35 was of the large intestine Polson (1927) reviewed the literature from 1916 He found 52 tumours and added 15 cases of his own One of these was a papilloma of the sacculus rotundus Fardeau (1931) could not add to the single tumour of the large bowel described by Polson

Hamster

The golden hamster is now a widely distributed and widely used laboratory animal but is of relatively recent introduction, all individuals having been derived from a single pregnant female found near Aleppo in 1930 Ashbel (1945) examined 1,000 animals and found 13 tumours of which none was of the intestine Fortner (1957 1958*a*, *b*) described tumours of the gastro intestinal tract appearing in both experimental and control groups of a total of 620 animals He believed all the tumours to be spontaneous and not induced by his experimental procedures Of 470 animals surviving 8 months or longer, 52 per cent were found to have tumours and 40 per cent of these had tumours of the large intestine Four types originated in the large intestine

Adenomatous polyps in 81 animals
Adenocarcinomas in 21 animals (one third with lymph gland metastases)

Leiomyosarcomas	in	2 animals (one with abdominal metastases)
Angiosarcoma	in	1 animal

It is not known whether environmental, genetic or other factors are responsible for the marked difference in incidence between the two strains It is known, however that at least 4 mutations involving coat colour (Piebald Ruby-eyed fawn Black eyed cream and Dark eared albino) have been recorded since 1945 and investigations on the differences of incidence of tumours in hamsters of different strains and the possible factors involved in their production should prove a fruitful field for future research

Guinea Pig

Tumours are very rare in guinea pigs Haagensen and Krehbiel (1936) state that in the 23 years up to 1936 only 2 spontaneous tumours have been found in guinea pigs at the Institute of Cancer Research of Columbia University while Tamaschke (1955) found only 17 tumours in the literature none being of the large intestine Warren and Gates (1941) reviewed the literature again finding no intestinal tumours They concluded that the guinea pig appeared to be resistant to the development of spontaneous tumours and to the production of induced tumours other than of the gall bladder Papanicolaou and Olcott (1942) stated that they have found 100 tumours in 7 000 guinea pigs and ascribed the large number to the fact that the animals were kept to an advanced age No tumour of the large gut was found there were 3 tumours attached to the small gut one liposarcoma and 2 neurolemmomas

Rat

Bullock and Rohdenburg (1917) reported 171 naturally occurring tumours in rats 123 of these being culled from the literature the remaining 48 being found in about 19 000 rats most of which were young No tumours of the large gut were found Bullock and Curtis (1930) and Curtis *et al* (1931) found 521 tumours in 489 tumour bearing rats They believed the tumours to be naturally occurring (all except 23 animals had been fed Taenia crassicollis eggs in experiments on Cysticercus sarcoma of the liver) They found 10 tumours of the caecum 7 sarcomas, 2 fibromas and one gelatinous carcinoma with lymph gland involvement

Ratcliffe (1940) described the results of post mortem examination of 273 tumour bearing rats from 2 colonies at the Wistar Institute He found no tumours of the large intestine but the animals were selected for examination by the personnel in charge of them as having abnormal swellings of some part of the body

Willis (1935) described 2 male white rats 36 weeks old killed 6 months after experimental injury to the testes They were either brothers or half brothers Each had a carcinoma of the proximal colon with involvement of lymph glands The present author has seen only two tumours of the large bowel of rats which he considered to be naturally occurring (see Walpole *et al* 1952 Walpole *et al* 1954) These were adenomas of the caecum in two aged female white rats of

Wistar origin which had been given subcutaneous injections of arachis oil as controls in experiments on carcinogenesis

Mouse

Slye *et al* (1917) described a single case of a squamous cell carcinoma arising on the surface of the prolapsed rectum of a male mouse aged over 2 years Wells *et al* (1938) in a series of 142,000 necropsies of mice of Slye stock found 18 primary tumours of the large gut distributed as follows one adenocarcinoma and 4 sarcomas of the caecum, 2 lymphosarcomas of the colon, 3 sarcomas of the rectum and one squamous cell carcinoma of the anus In prolapsed rectums there were 2 adenocarcinomas and 5 squamous cell carcinomas A single case of a squamous cell carcinoma in the prolapsed rectum of a mouse of the inbred strain F was described by Strong *et al* (1936) while Miller and Pybus (1956) described 2 tumours of the large bowel, one a potential adenocarcinoma of the colon and the other an adenoma of the rectum found in mice of two hybrid strains obtained by reciprocal crosses between strains NBT and CBA with subsequent inbreeding for 12 generations

Cloudman (1941) stated that at the Roscoe B Jackson Laboratory over 20,000 mice had developed naturally occurring tumours A few intestinal polyps had been found, in one of which early carcinomatous change was seen carcinomas were very rare Guerin (1954) described a spindle cell sarcoma on the external surface of the ascending colon of a 20 month old female mouse The tumour had metastasized

WILD MAMMALS

Marsupials

Fox (1930) described a medullary carcinoma of the rectum of a male common dasyure (Dasyurus viverrinus) The tumour was about 5 cm from the anus and appeared to have obstructed the bowel

Insectivora

Murray (1919) reported a fibromyoma arising from the circular muscle coat of the large intestine of a hedgehog The tumour was loosely impacted in the pelvis

Primates

Ratcliffe (1930) described an adenocarcinoma of the rectum in a toque macaque (Macacus pileatus) which died in the Philadelphia Zoological Garden The tumour had extended to the prostate, and death was apparently due to haemorrhage from the cancer

Rodents

One hundred thousand wild rats were examined at the federal plague laboratory, San Francisco by McCoy (1909) One hundred and three tumours were

found, but none was of the gastro intestinal tract Wooley and Wherry (1911) similarly examined 35 000 wild rats during a campaign for the eradication of plague in San Francisco, they found 23 tumours in 21 rats but again none was of the intestine

Hilgendorf and Paulicki (1870) described a poorly differentiated carcinoma of the caecum with secondary deposits in the peritoneum in an agouti (Dasyp rocta azarae) while a lymphosarcoma of the caecum was found in a male agouti of another species (Cuniculus paca) by Ratcliffe (1933) Hamerton (1939) reported a polypoid cystic adenoma of the caecum of a fat sand rat (Psammomys obesus) the tumour completely obstructed the caecum and there were no metastases

Carnivora

A carcinoma of the caecum of a genet (Genetta genetta) was reported by Lombard and Witte (1959), Ratcliffe (1933) reported a squamous cell carcinoma of the rectum in a tiger (Felis tigris) and Fox (1929) described a squamous cell carcinoma of the anus in a male Sumatran tiger (Felis tigris sondaica) The latter tumour was known to have been present for two years, and the animal was killed because of its appearance There were no metastases

Ungulates

A teratoma of the anus of a buffalo was recorded by Cameron (1923) who examined 250 animals on the occasion of the reduction of the herd at the National Buffalo Park Wainwright Ratcliffe (1933) described a fibrosarcoma of the caecum in a zebra (Equus b burchelli) The tumour had produced metastatic deposits in the lung

INDUCED TUMOURS OF THE LARGE INTESTINE

Radiations

Yttrium^{91} a pure beta emitter, was fed by stomach tube by Lisco *et al* (1947) to rats Following a single large feed 4 out of 33 animals developed adenocarcinoma of the colon while after repeated small feeds at three dose levels 6 out of 8 rats at the two higher levels died with carcinoma of the colon

Lethal doses of X rays (700–1 000 r) were administered to Sprague Dawley rats by Brecher *et al* (1953) the animals being protected by treatment with glutathione p aminopropiophenone or by parabiosis Four carcinomas of the intestine occurred in 21 rats of which one was a sessile polyp of the colon with local invasion up to but not into the muscularis externa

Sixteen months after sublethal (290–580 rep) whole body fast neutron irradiation of 221 LAF_1 mice Nowell *et al* (1956) found intestinal tumours in 17 out of 63 mice which had died Eleven in the caecum were mucoid adeno carcinomas showing extensive local invasion and frequent metastasis to regional lymph nodes Following slow neutron irradiation Upton *et al* (1954) reported

having found 2 tumours of the intestine in male mice, but gave no further details

Lesions of the bowel were reported by Bond *et al* (1952) after a single deuteron irradiation (1,800–2,800 rep) of segments of rat gut applied through the intact skin Following replacement of the gut wall with fibrous tissue, there was marked epithelial proliferation at the edges of the lesions resulting in well differentiated glands frequently extending into the muscularis The authors did not know whether the lesions were neoplastic

Undefined Substances

Chabad (1927) introduced tar into the rectum of 56 white mice 2 to 3 times a week for 7 months No tumours of the rectum resulted, while Lushbaugh and Hackett (1948–49) fed a motor lubricating oil (S G F No 1 oil) to rats When the oil was fed in a natural diet, a single adenocarcinoma of the colon with lymph node involvement was obtained, and when given in a synthetic diet half the animals produced adenomatous infiltrating mucosal lesions The authors doubted whether the latter lesions were truly neoplastic

Polycyclic Hydrocarbons

20 methylcholanthrene may be regarded as a type substance for the polycyclic hydrocarbons which produce a carcinogenic effect locally at the site of application Methylcholanthrene fed to mice produces tumours of the stomach and small gut, but not of the large gut (see Lorenz and Stewart 1940 1947, Stewart and Lorenz 1942, 1947, and White and Stewart 1942) Mori *et al* (1955) succeeded, however, in producing an adenocarcinoma of the colon in one of 12 rats which had been fed methylcholanthrene at high dosage

Epithelial tumours of the large gut cannot be obtained in high yield by injection of methylcholanthrene into the rectal wall (see Duque, personal communication to Stewart (1953) and Rack *et al* 1955) though sarcomas have been obtained by Berenblum *et al* (1956) nor can they usually be obtained in high yield by instillation of methylcholanthrene into the lumen of the rectum (Van de Schueren and Vermeire 1942 Stewart 1953, Rack *et al* 1955, and Berenblum *et al* 1956) Horava and von Haam (1958) have however produced epithelial tumours by introducing a cotton thread impregnated with methylcholanthrene into the caeco appendix of Wistar rats and allowing the free end to be carried to the anus by peristalsis Of 42 animals at risk for 48 weeks 7 showed carcinoma *in situ* and 19 invasive carcinoma The authors suggested that the absence of sarcomas as produced by Berenblum *et al* (1956) might be due to lack of solvent for the carcinogen in their experiments

Aminofluorenes

2 acetylaminofluorene is a versatile carcinogen producing tumours in a variety of organs when given by mouth Tumours of the large gut are produced in low yield thus Cox *et al* (1947) reported that of 84 albino rats developing multiple tumours only 2 developed adenocarcinoma of the colon Bielchowsky

(1944) found three cancers of the intestine in 104 rats One of these tumours was a carcinoma of the caecum which had metastasized to the liver Comparing the tumours produced in two strains of rats by 2 acetylaminofluorene, Bielchowsky (1946) found no difference in the incidence of carcinomas of the colon between the two strains, finding 2 carcinomas in 38 Piebald rats and 14 in 300 Wistar rats Morris (personal communication to Dukes 1959) has found a related compound, 2 7 diacetylaminofluorene to produce intestinal tumours in high yield in both male and female rats

Aminodiphenyls

4 4 diaminodiphenyl (benzidine) produces tumours of the liver acoustic gland and intestine of rats after subcutaneous injection Spitz *et al* (1950) reported 7 instances of adenocarcinoma of the rectum among 385 rats injected subcutaneously with benzidine all these occurred in males 200 or more days after injections were begun These carcinomas arose at the junction of the colon and rectum generally encircled 1–2 cm of the length of the gut and extended through the wall into the surrounding tissues No metastases were found

Baker (1950) isolated a substance from the urine of workers manufacturing or handling benzidine which he identified as a dihydroxy benzidine (probably 3 3 dihydroxy-4 4 diaminodiphenyl) and has shown (personal communication to Walpole *et al* 1952) that it rapidly produces intestinal tumours when fed to rats

Walpole *et al* (1952) found tumours of the bowel after injection of 4 aminodiphenyl subcutaneously into rats of Wistar origin The tumours were in 7 out of 14 rats which were at risk for over 500 days and were confined to the large bowel A methyl homologue of 4 aminodiphenyl 3 2 dimethyl-4 aminodiphenyl was even more potent as a carcinogen of the intestine tumours of the gut occurring in 31 out of 33 animals In almost every case they were multiple and appeared along the whole length of the large and small intestine in only one rat did a tumour occur in the small gut alone

The tumours of the large intestine varied in type and in extent Some were adnomatous polyps, others sessile adenomas while in the most marked lesions disorganized and atypical glands repeatedly penetrated the submucosa and invaded or penetrated the muscularis externa forming cystic projections on the bowel surface covered with thickened peritoneum At that time the authors in the absence of evidence of metastasis were not prepared to commit themselves as to the nature of these advanced lesions Metastasis has however, been observed in later experiments and it is now evident that true carcinomas of the gut can be obtained with this type of carcinogen

In later papers Walpole *et al* (1954*b*) described intestinal tumours in rats of Wistar origin produced by 2 other methyl derivatives of 4 aminodiphenyl (3 3 dimethyl-4 aminodiphenyl and 3 methyl-4 aminodiphenyl) and Walpole *et al* (1955) showed that rats of the Slonaker strain were relatively resistant to the production of intestinal tumours by 3 2 dimethyl-4 aminodiphenyl

It appears that the parent aminodiphenyls described above are not carcinogens themselves but that the active principle is a metabolite Walpole *et al*

(1952) and Clayson (1953) suggest that the metabolites concerned may be orthohydroxy amines, an hyopthesis strengthened by the findings of Bradshaw and Clayson (1955)

Comparative mammalian oncology is at the present time an unfashionable and somewhat neglected branch of cancer research and is wrongly regarded by some merely as an exercise in pathological systematics, yet there is much to be learnt by its study of direct value to problems of cancer in the highest mammal —man Differences between cancer in man and in animals exist, but these are not fundamental, they are an expression of species divergence and of differing ways of life, and are in themselves valuable in the investigation of the genesis and of the biology of neoplasia

Cancer is ubiquitous throughout the animal kingdom, being found wherever it is diligently sought and a wider appreciation of the contribution which modern comparative pathology can make to the investigation of human cancer is urgently required

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CHAPTER VI

THE PATHOLOGY OF RECTAL CANCER

CUTHBERT E DUKES

RECTAL cancer is a disease which progressively undermines the health of its victim and will eventually kill the patient unless death happens to occur meanwhile from some other cause At the present time the only prospect of cure for rectal cancer is by radical surgery which as we know is successful in some cases but not in all Many different factors influence the prognosis of the patient treated by radical surgery such as the age and general health of the patient the skill and experience of the surgeon the surgical operation adopted and the nursing and after care in the critical post operative period Both patient and surgeon are fully aware of the importance of all these but there is another factor influencing prognosis of which the patient is usually blissfully ignorant though the surgeon often reflects on its supreme importance namely the pathology of the tumour All other factors affecting prognosis after the surgical treatment of rectal cancer dwindle into insignificance when compared with this *Pathology* decides the issue in the vast majority of cases

The features in the pathology of rectal cancer which are of most importance from the point of view of prognosis are the gross characters of the tumour its histology and its extent of spread at the time of removal Each of these will be considered in turn

GROSS CHARACTERS OF RECTAL CANCER

The actual size or surface area of a rectal cancer is of less importance than might be anticipated A very early tumour is most likely to be small and a very advanced tumour may be large but there is no invariable relationship between the surface area and the extent of lymphatic or venous spread For instance a small shallow ulcer of high grade malignancy may have spread far and wide in lymphatic and venous channels whereas a fungating tumour of much larger dimensions may still be localized to its site of origin In general shape is of more clinical importance than size Protuberant tumours are often of a low grade of malignancy growing slowly and tending to metastasize late On the other hand deep ulceration is usually a sign of high infiltrating and metastasing potential

On the basis of gross characteristics the following five varieties of cancer of the rectum may be distinguished

(1) Malignant adenoma a somewhat contradictory term is used to describe the development of carcinoma in a pre existing adenoma

(2) Similarly Malignant papilloma' describes a focus of carcinoma developing in a pre existing villous papilloma In both these the greater part of the growth is benign and the malignant disease which is present is often at an early stage of development

(3) Protuberant type of carcinoma These tumours usually extend over a fairly wide area and do not as a rule penetrate deeply into the muscle They tend to remain localized and are slow to give rise to metastases

(4) Ulcerating carcinoma This is the commonest form At the time of diagnosis an ulcerating carcinoma has generally spread over at least two or three quadrants and may have completely encircled the bowel, forming an oval ulcer with *raised everted edges*

(5) The term stenosing carcinoma , or scirrhous carcinoma is applied to a type of tumour which extends completely around the bowel, narrowing its lumen

Microscopical Appearances of Rectal Cancer

The three main histological varieties of rectal cancer are adenocarcinoma, colloid (or mucinous) carcinoma and an undifferentiated variety usually called anaplastic carcinoma simplex

1 Adenocarcinoma

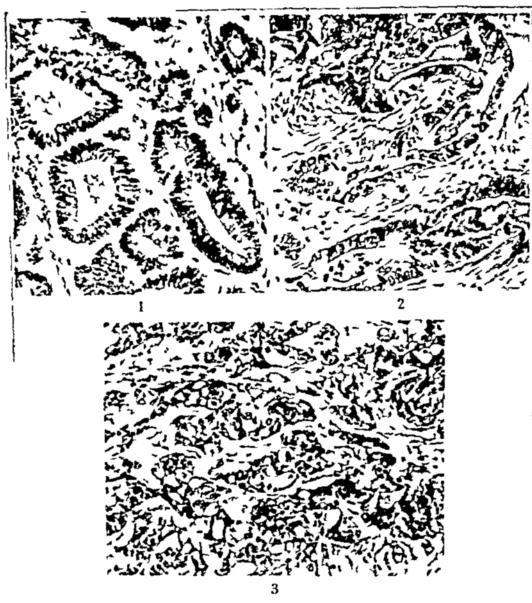
This is the commonest variety constituting nearly 90 per cent of all cases Its histological characteristics are well known and it is sufficient to point out that though the tumour usually shows a tubular or acinar pattern there is as a rule little evidence of mucus secretion either in the cells or glandular spaces Adenocarcinoma is a large group and may be further subdivided according to the degree of differentiation of the tumour cells into three sub groups (*i*) low grade malignancy (*ii*) average grade malignancy, and (*iii*) high grade malignancy These are illustrated in Figures 25 to 27

2 Colloid or Mucus-secreting Carcinoma

This is the second commonest variety of rectal cancer, constituting approximately 9 per cent of cases It has a similar basic structure to adenocarcinoma, but differs in that a large quantity of mucus is secreted When the mucus is stored in individual cells these have a signet ring appearance If the secretion is chiefly extracellular the carcinoma cells are seen floating in lakes of the colloid or mucinous secretion

3 Carcinoma Simplex

This term describes an anaplastic type of carcinoma composed of polygonal or spheroidal cells which are scattered about singly or in small clusters It may be difficult to decide whether such a tumour is a sarcoma or carcinoma but *some part generally has features characteristic of carcinoma*



EXPLANATION OF PLATE

FIG 25 Rectal carcinoma Low grade malignancy × 140
FIG 26 Rectal carcinoma Average grade malignancy × 140
FIG 27 Rectal carcinoma High grade malignancy × 140

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EXAMINATION OF OPERATION SPECIMENS

The examination of an operation specimen of rectal cancer provides the pathologist with an opportunity of making observations on the histology of the tumour the extent of local spread by direct continuity, the presence position and number of

lymphatic metastases and the evidence of spread within the lumen of veins The prognostic significance of these will be considered in turn, but we must first point out that subsequent pathological investigations are made much easier if care is taken in the initial treatment of the operation specimen

The plan adopted for the examination of operation specimens of rectal cancer and the dissection of the lymph nodes and blood vessels has already been describ d (Gabriel Dukes and Bussey, 1935) and may be briefly recapitulated as follows

Immediately after removal the specimen is sent to the Pathological Laboratory where it is cut open along its anterior (anti mesenteric) border sewn on to a per forated metal frame and fixed in 10 per cent formalin solution for at least 48 hours The fixed specimen is then photographed and dissected The dissection begins at the point of division of the vascular pedicle and is directed at exposing the superior haemorrhoidal vessels and their branches until they disappear through the muscle coat into the submucosa During this process most of the accompanying lymph nodes are discovered the remainder being usually palpable in the thin wedges of fatty tissue left between the vessels At the same time any growth extending along the veins is detected

A natural sized tracing of the specimen and its salient anatomical features is easily made by means of carbon paper placed beneath oiled silk The lymph nodes are plotted on to this map in a numbered sequence and then taken for section which is facilitated by pinning 15 or 20 nodes to a wooden block the pins being removed after the block has been embedded in wax After microscopical confirmation the position of lymphatic metastases and any venous invasion are noted on the map as is also the presence of local spread which is determined by a transverse cut through the centre of the tumour

Histological Grading

As already mentioned adenocarcinoma of the rectum may be subdivided into three histological sub groups designated as low, average and high grades of malignancy—these distinctions being based on cellular arrangement and differentiation (Figs 25–27)

The close dependence of prognosis on the histology of a rectal carcinoma is shown by the fact that the corrected 5 year survival rate of surgically treated patients at St Mark s Hospital who were reported as having low grade car cinomas was 77 3 per cent For those of average grade it was 60 6 per cent and for high grade malignancy tumours 28 9 per cent (Table IV)

TABLE IV

Relation of Grade of Malignancy to 5 year Survival After Surgical Treatment

	All cases	
	Number of cases	*Corrected 5 year survival rate (per cent)*
Low grade	407	77 3
Average grade	1266	60 6
High grade	424	28 9

LOCAL SPREAD

The term local spread is used to describe spread by *direct continuity* from the original point or points of origin With rectal cancer local spread may vary greatly in extent It may be classified as (1) confined to the bowel wall (no extra rectal spread) (2) commencing to invade the extra rectal tissues (slight local spread), (3) well established in the mesentery (moderate spread) or (4) deeply invasive possibly into neighbouring organs (extensive spread)

The survival rates for these three subdivisions of local spread in a consecutive series of 523 patients *without lymphatic metastases* is recorded in Table V, which illustrates in a convincing way the adverse effect on prognosis of increasing degree of local spread As local spread increases there is also an increased liability to dissemination of cancer cells by lymphatic and venous channels and evidence for this will be provided later

TABLE V

Relationship Between Local Spread and 5 year Survival Rates After Surgical Treatment

Cases without lymphatic metastases

	Number of cases	*Corrected 5 year survival rate (p r cent)*
Slight extra rectal spread	266	89 7
Moderate extra rectal spread	109	80 0
Extensive extra rectal spread	148	57 0

LYMPHATIC SPREAD

When cases of rectal cancer are divided into two groups those *with* and those *without* lymphatic metastases very striking differences are noticed in the prospect of survival after surgical treatment In the series of cases reported by Dukes and Bussey (1958) the corrected 5 year survival rate for men without lymphatic metastases (A and B cases) was 82 5 per cent but was only 31 1 per cent for men patients with lymphatic metastases (C cases) The corresponding figures for women were for those without metastases 86 2 per cent and for those with metastases 33 1 per cent

TABLE VI

5 year Survival Rates of Cases With and Without Lymphatic Metastases

	Number of cases	*Corrected 5 year survival rate (per cent)*
Men		
Without metastases (A and B cases)	683	82 5
With metastases (C cases)	641	31 1
Women		
Without metastases (A and B cases)	317	86 2
With metastases (C cases)	396	33 1
Both sexes		
Without metastases (A and B cases)	1000	83 7
With metastases (C cases)	1037	32 0

The dividing of all cases into two groups in this way, according to whether or not lympathic metastases have been found, tends to exaggerate the significance of lymphatic spread and to disguise the fact that if lymphatic spread is still at an early stage the prognosis may still be relatively good This becomes clear when cases with metastases are further subdivided on the basis of the position and number of the metastases

To illustrate the importance of the position of metastases all C cases in this series were further subdivided into two groups If only the regional lymph nodes contained metastases the case was classified as C 1', whereas if there was more extensive lymphatic spread involving the nodes at the point of ligature of the blood vessels the case was described as 'C 2 (Fig 28) A comparison of the survival rates of these two groups is recorded in Table VII from which it will be seen that the corrected 5 year survival rate for C 1 patients was 40 9 per cent but only 13 6 per cent for the C 2 patients

TABLE VII

Comparison of Survival Rates of C 1 and C 2 Cases

	Number of cases	*Corrected 5 year survival rate (per cent)*
C 1 cases	680	40 9
C 2 cases	282	13 6
Unclassified	75	19 6
Total	1037	32 0

To investigate the significance of the number of metastases cases with lymphatic spread were further subdivided into convenient groups as follows one metastasis only, 2–5 metastases, 6–9 metastases and 10 or more metastases The analysis of these sub groups is recorded in Table VIII from which it will be seen that the corrected 5 year survival rate of those patients in whom only one metastasis was found was 63 6 per cent but after this prognosis worsened with increase in number of metastases The corrected 5 year survival rate for patients with more than 10 metastases was only 2 1 per cent

TABLE VIII

Influence of Number of Lymphatic Metastases on Survival After Surgical Treatment

Number of lymphatic metastases	*Number of cases*	*Corrected 5 year survival rate (per cent)*
1	125	63 6
2–5	249	36 1
6–10	138	21 9
More than 10	52	2 1

SPREAD WITHIN VEINS

The presence of a solid plug of carcinoma cells within the veins of an operation specimen would seem at first to be of very sinister significance but

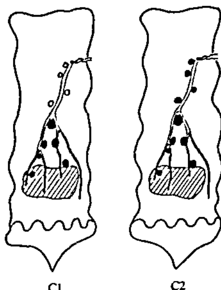


FIG 28

Subdivision of cases with lymphatic metastases into C1 and C2

it has not proved to be as bad as might be expected In the St Mark s series the follow up on 197 cases with this type of venous spread has shown a 5 year survival rate of 35 4 per cent One hundred and forty five of these 197 cases had also lymphatic metastases and the survival rate for these was 25 9 per cent Fifty two of the cases with venous spread had no lymphatic metastases and the 5 year survival rate for these was 64 per cent

At present the numbers are scarcely large enough for more detailed statistical analysis but so far it would seem that in most cases the discovery within veins of growth of the character described does little more than worsen the prognosis slightly

INTERDEPENDENCE OF HISTOLOGY AND SPREAD IN RECTAL CANCER

By using the corrected 5 year survival rate an attempt may be made to estimate separately the degree to which the prognosis of rectal cancer is dependent on its histology and on the extent of local lymphatic and venous spread If these various features had been completely independent of each other the individual contribution to the death rate made by each might be assessed separately from 5 year survival rates but obviously the factors measured individually are closely interrelated and interdependent and each factor might have been used as a partial measure of the others It seems almost as if one were looking at the same picture from different points of view because each pathological feature recorded is only another expression of the growth potential of the primary tumour

This interdependence of different factors in the pathology of rectal cancer though it vitiates any detailed assessment of separate factors is advantageous

in that it permits opinions to be formed by inference from partial observations only, for instance, valid assumptions may be deduced from the histology of a biopsy fragment and from clinical observations concerning the extent of local spread

A, B, AND C CLASSIFICATION

The A, B, C classifications of rectal cancer (Fig 29), based on the extent of spread, has been used on all surgically treated cases in the St Mark s series, and has proved to be a convenient and practical method of summarizing a pathological report The crude 5 year survival rate of A cases (growth limited to rectum, no extra rectal spread, no lymphatic metastases) was 81 2 per cent The crude 5 year survival rate of B cases (spread by direct continuity into extra rectal tissues, no lymphatic metastases) was 64 0 per cent The crude 5 year survival rate of C cases (lymphatic metastases present) was 27 4 per cent After making allowances for inter current deaths during the 5 year period the 'cor rected 5 year survival rate for A cases was 97 7 per cent, for B cases 77 6 per cent and for C cases 32 0 per cent

Before concluding this chapter on the pathology of rectal cancer it should be pointed out that almost all the data collected with regard to prognosis has

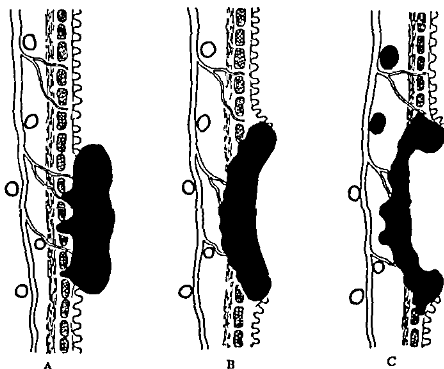


FIG 29

Classification of rectal cancer into three stages according to extent of spread A cases—limited to wall of rectum B cases —with extra rectal spread by no lymphatic metastases C cases—with metastases in lymph nodes

been based on the examination of operation specimens and is applicable therefore only to surgically treated patients The only contribution the pathologist can make before operation is by the microscopic examination of a biopsy fragment and by grading the tumour if it proves to be malignant At the time of operation the surgeon may be able to estimate the extent of local spread and base prognosis on this but estimates of surgeons at the time of operation tend to err in supposing that local spread is more extensive than later proves to be the case This is because in the operating theatre inflammatory adhesions may be mistaken for malignant growth and glands enlarged as the result of sepsis may be mistaken for metastases

CONCLUSION

I began by pointing out that many different factors influence the prognosis of the patient who has been treated surgically for rectal cancer but expressed the opinion that the most important of these is the pathology of the disease at *the time of surgical treatment I have described the factors in pathology which* influence prognosis and laid stress on the histology of the tumour and the extent of local and lymphatic spread and will conclude by saying that the pathological procedures which have been described do not demand any special pathological training or skill but they do require that the laboratory examination should be carried out in a thorough and systematic fashion In the attempt to maintain a high standard in this it is some consolation to the pathologist to know that he is making an indispensable contribution to the understanding and control of the disease which his surgical colleagues are treating with so much devotion and skill

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CHAPTER VII

THE PATHOLOGY AND RESULTS OF TREATMENT OF SQUAMOUS CELL CARCINOMA OF THE ANAL REGION

BASIL C MORSON

SQUAMOUS cell carcinoma of the anal region is an uncommon form of malignant disease During the years 1928–56 157 cases were seen at St Mark s Hospital This is 3 5 per cent of patients with adenocarcinoma of the rectum seen during the same period a figure which compares closely with reports from other centres (Grinnell 1954) The study of anal cancer has been overshadowed by the immense effort put into research on rectal malignancy and the literature is correspondingly much smaller Moreover the relatively small number of cases reported (Gabriel 1941 Bacon *et al* 1951, Grinnell 1954, Stearns 1958) has made an accurate analysis of the pathology and prognosis difficult Now that a total of 157 cases have been accumulated at St Mark s Hospital it is possible to give a fairly accurate estimate of the pathology and results of treatment

Gabriel (1941) showed that there were good reasons for distinguishing between carcinoma of the anal canal and carcinoma of the anal margin and his findings have been largely confirmed by an analysis of the 157 cases at St Mark s Hospital some of which were part of his original series

Anal canal cancer is defined as a tumour which lies above mainly above or astride the dentate line which is the line of the anal valves Anal margin tumours are those which lie mainly below and completely below the dentate line By these criteria it has been possible to site all but 16 of the 157 cases The exceptions were either very large growths or records did not permit an accurate estimate of their situation

It is not generally realized that squamous carcinoma of the anal canal may arise from epithelium entirely above the level of the anal valves (Fig 30) Of the 141 cases in this series in which the site of origin of the anal cancer could be determined 85 (or about 60 per cent) arose above or mainly above the dentate line Thirty eight tumours out of the 141 sited cases (or about 27 per cent) were entirely above this level It is clear that the upper anal canal is the commoner site for the development of squamous cell carcinoma

This part of the anal canal above the level of the anal valves is a narrow transitional zone seldom more than half an inch deep Its epithelial lining is extremely variable and may consist of a transitional type of mucosa resembling urinary tract epithelium stratified columnar epithelium and squamous mucous membrane Moreover these epithelia cover the internal haemorrhoidal plexus and are therefore subject to excessive trauma and chronic irritation with meta



Fig 30

Small squamous cell carcinoma arising above the level of the anal valves with slight upward spread into the lower rectum and some downward spread beneath an anal valve (Mr A G Parks s case)

plasia to a more cornifying type of squamous mucosa It is possible that long standing irritation of the epithelium in this upper part of the anal canal is a predisposing factor in the development of carcinoma

ANALYSIS OF 157 CASES OF SQUAMOUS CELL CARCINOMA OF THE ANAL CANAL AND ANAL MARGIN

Sex and Age Incidence

The sex incidence is nearly equal with a slight preponderance of males over females (115 males per 100 females) In rectal cancer there are approximately two males for every female However if anal canal tumours as defined above are compared with anal margin tumours it is apparent that anal canal cancer is more common in females in a proportion of about 3 2 whereas anal margin tumours are four times more common in men There is no difference in the average age at the two sites The average age of the whole series of 157 patients is 58 5 years, which is not significantly different when compared with the average age of patients with rectal cancer (60 4 years)

Incidence at the Two Sites

Out of 157 cases there were 103 tumours of the anal canal and 38 tumours of the anal margin Sixteen tumours were not classified for site Thus anal canal tumours are nearly three times more common than tumours of the anal margin

There is no evidence to suggest from a study of these cases that any one quadrant of the anal canal or anal margin is more prone to squamous carcinoma than another

Histology

The histological structure of squamous cell carcinoma of the anal region is very variable The reasons for this are twofold Firstly the anal canal is lined by different varieties of epithelium which may include a transitional type resembling urinary tract epithelium simple non keratinizing stratified squamous epithelium and true skin Stratified columnar epithelium may be found in the region of the anal crypts and lining the anal intramuscular glands Secondly the epithelium is subject to trauma and chronic irritation often due to haemorrhoids leading to epithelial instability and metaplasia The wide range of types of epithelium found in the anal canal as well as individual variability has been emphasized by Walls (1958) It is probable also that the anal epithelium is modified as age advances

A study of the histology of the 157 cases of squamous cell carcinoma seen at St Mark s Hospital reveals two main types

1 Mainly non keratinizing squamous cell carcinoma These tumours are all found in the upper part of the anal canal
2 Keratinizing squamous cell carcinoma arising mostly from the anal margin and peri anal skin

The non keratinizing type of squamous cell carcinoma (Figs 31 and 32) resembles tumours found in the cervix and pharynx where the epithelial lining as in the upper part of the anal canal is normally of the non keratinizing squamous type They may resemble bladder carcinoma and are sometimes called tran



FIG 31

Non keratinizing squamous cell carcinoma of anal canal (transitional cell type)

sitional cell carcinomas However a careful search usually shows some attempt at keratin formation or occasional epithelial pearls Prickle cells are not found in this type of anal carcinoma Other variations include a basi squamous appearance and care must be taken not to confuse these with basal-cell carcinoma or rodent ulcer of the peri anal skin for the basi squamous cell car-



FIG 32
Mainly non keratinizing squamous cell carcinoma of anal canal

cinoma of the anal canal is a metastasizing tumour A cylindromatous type of squamous cell carcinoma has also been observed in this series

According to Hamperl and Hellweg (1957) the anal canal is one site where muco-epidermoid carcinomas may be found The 157 cases in this series were all specially stained for mucus secretion and this was found in 23 cases (Fig

33) In approximately half this number the mucus was obvious in an ordinary haematoxylin and eosin section All these *muco epidermoid tumours* were found in the upper part of the anal canal, either above or mainly above the dentate line In this part of the anal canal there is a junctional or transitional



FIG 33

Muco-epidermoid carcinoma of anal canal The clumps of squamous cells show central secretion which stains bright red with mucicarmine This secretion appears jet black in the photograph

zone between rectal mucosa and anal epithelium which is very subject to epithelial instability

Keratinizing squamous cell carcinoma with prickle cell formation is characteristic of anal margin cancer (Fig 34) However such tumours may also



Fig 34

Typical keratinizing squamous cell carcinoma mostly found in anal margin tumours

be seen in the upper part of the anal canal where they arise on a basis of pre existing chronic irritation or inflammation with metaplasia of the upper anal canal epithelium to a cornifying type of squamous mucous membrane This metaplasia may extend upward into the rectum and may account for some of those cases of squamous cell carcinoma which apparently arise from the lower third of the rectum Squamous cell carcinoma has also been described in the middle and upper thirds of the rectum, but this is extremely rare

Spread

Squamous cell carcinoma of the anal canal shows preferential direct spread upwards into the lower third of the rectum (Fig 35) and this explains why many

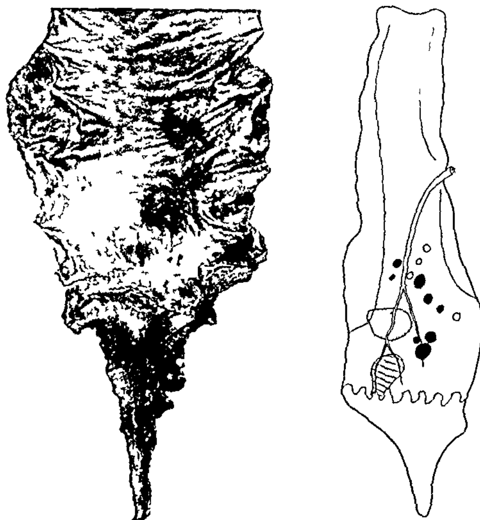


Fig 35

Squamous cell carcinoma apparently arising above the level of the anal valves with extensive direct spread upwards into the rectum This direct spread has occurred in the submucous layer and has re-erupted through the rectal mucosa The accompanying chart shows the extent of this spread (stippled zone) as well as eight haemorrhoidal lymphatic metastases (Mr W B Gabriel s case)

anal canal cancers present clinically as tumours of the lower rectum Direct spread occurs by permeation of malignant cells along lines of least resistance such as tissue spaces and natural anatomical clefts In the case of anal canal cancer the line of least resistance appears to be upwards in the submucous layer often with secondary ulceration through the rectal mucosa (Fig 35) Down ward spread is probably held up by the arrangement of the anal musculature and in particular by the mucosal suspensory ligament (Parks 1956) The anal mucosa is more tightly bound down to its underlying muscles than is the case with the rectal mucous membrane

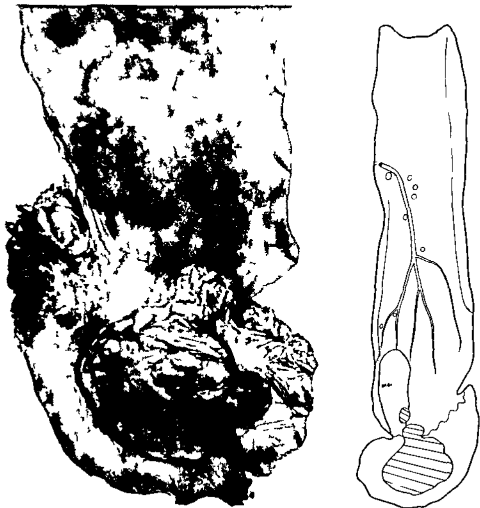


Fig 36

Large squamous cell carcinoma of the anal margin with upward spread into the anal canal and erosion of the anal sphincters There are also some submucous nodules of growth at the level of the ano-rectal ring There were no haemorrhoidal lymphatic metastases but an inguinal gland recurrence was detected five months after excision of the rectum (Mr O V Lloyd Davies s case)

Anal cancer spreads to the superior haemorrhoidal group of lymph glands, the glands on the lateral walls of the pelvis and to the inguinal glands There was haemorrhoidal gland involvement in 42 9 per cent of major operation cases in this series Clinical and pathological evidence showed inguinal glend involvement in 35 per cent of all cases of anal canal and anal margin cancer However, the incidence of inguinal gland metastasis in anal margin disease (39 5 per cent) is slightly higher than the incidence for anal canal cancer (35 9 per cent)

It is significant that none of the nine cases of anal margin cancer treated by a radical excision of the rectum showed any involvement of the haemorrhoidal glands (Fig 36) Moreover, those anal margin cases treated by local excision which did not survive five years mostly had an inguinal gland recurrence It would appear that anal margin disease is best treated by local excision if possible but the inguinal recurrence remains a problem

No figures are available for the venous spread of anal cancer in this series of cases However evidence of permeation of veins was found quite frequently in histological sections, particularly in the submucous veins of the upper anal canal and lower rectum

Treatment

An analysis of the treatment of anal cancer at St Mark's Hospital is given in Table IX It shows that nearly 80 per cent of anal canal tumours were treated by a radical operation, only 6 cases out of 99 being treated by local excision, and these were very small tumours The 14 cases classified as growth not removed include inoperable cases and those treated by radiotherapy alone *In* contrast, local excision has been the most favoured treatment for anal margin disease, but in nine cases the growth was extensive enough to require a radical excision

TABLE IX

Group	*Diagnosis only*	*Not treated by surgery*	*Local operation*	*Major operation*
Anal canal	4	14 14 1	6 6 1%	79 79 8%
Anal margin	1	8 21 6	20 54 1%	9 24 3
Not stated	1	11 73 3	1 6 7	3 20 0

Prognosis

The crude 5 year survival rate of all 157 cases of squamous cell carcinoma of the anal region is 42 6 per cent, which is slightly better than the crude 5 year survival of all cases of adenocarcinoma of the rectum Stearns (1958) records a 5-year survival of 41 per cent and Grinnell (1954) agrees that anal cancer has a slightly better prognosis

If the 5 year survival rate is broken down for site that is into anal canal and

anal margin tumours the figures show that the prognosis of anal margin disease is more favourable than in anal canal cancer the crude 5 year survival rate for anal margin cancer being 51 4 per cent and for anal canal cancer 42·4 per cent Moreover, this better 5 year survival occurs despite the fact that most anal margin tumours were treated by local excision whereas the majority of anal canal cancers were treated by a radical operation

One reason for the better prognosis in anal margin cancer might be that this site is more favourable to early clinical diagnosis Another reason is apparent from the study of the histology of squamous cell carcinoma of the anus Most anal canal tumours are poorly differentiating non keratinizing squamous cell carcinomas and in this series only 45 1 per cent produced any keratin at all and this mostly in small amounts On the other hand 84 2 per cent of the anal margin tumours produced keratin and mostly in considerable quantity For a great many years it has been customary to regard keratin production as a rough guide to the degree of malignancy of squamous cell carcinomas The greater the amount of keratin production the lower the grade of malignancy

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CHAPTER VIII

RARE MALIGNANT TUMOURS OF THE RECTUM AND ANAL REGION

BASIL C MORSON

Carcinoid

CARCINOID tumours of the rectum usually present as small submucosal nodules about a centimetre in diameter (Fig 37) They rarely give rise to symptoms and are mostly found accidentally during rectal investigation of anal symptoms due to other causes Clinically they may be mistaken for a simple adenoma or a benign lymphoma of the rectum Small submucosal carcinoids may sometimes be found in operation specimens removed for rectal cancer

Twenty one cases of rectal carcinoid have been seen at St Mark s Hospital during 25 years Twelve were in males and 9 in females their ages varying from 24 to 68 with a mean of 44 years

Seven of the 21 tumours in the St Mark s series had the histological appearance of carcinoid of the ileocaecal region together with the typical cyto



FIG 37

Small submucosal carcinoid of rectum treated by local excision The clumps of tumour cells lie in the submucosa and the deep part of the mucous membrane

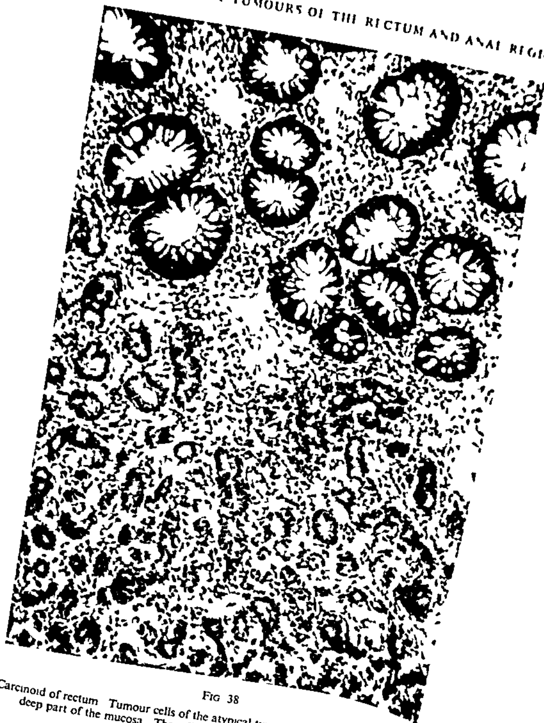


FIG 38

Carcinoid of rectum Tumour cells of the atypical type of rectal carcinoid invading the deep part of the mucosa The cells are arranged in an adenomatous pattern

plasmic granules after treatment with the silver impregnation and Diazo techniques but two showed cytoplasmic granules in only a minority of [illegible] tumour cells Fourteen of the 21 cases corresponded with the atypical form of rectal carcinoid described by Stout (1942) These had a distinctive [illegible] logical

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appearance, most of the cells being arranged in an adenomatous pattern (Fig 38) None of these atypical carcinoids showed the cytoplasmic granules characteristic of ileocaecal carcinoid

The histology of these atypical rectal carcinoids and the absence of cytoplasmic argentaffin granules suggests that their histogenesis is different from the conventional ileocaecal type of tumour (Morson 1958) It is probable that the 'atypical' carcinoids arise from non granular and non secretory cells at the base of the crypts of Lieberkuhn which are in an early stage of differentiation not having yet acquired the ability to produce cytoplasmic granules or mucus None of the St Mark s cases of submucosal rectal carcinoid showed any mucus secretion

All but one of the 21 cases of rectal carcinoid seen at St Mark's were treated by local excision None has recurred or developed metastases One case was treated by a radical operation but no metastases were found and the patient has remained well Local excision is certainly the correct treatment for the small submucosal variety of rectal carcinoid but such patients should return at regular intervals for a follow-up examination

Some patients with rectal carcinoid certainly do develop metastases Horn (1949) and Jackman (1954) both report such cases but there has been only one example of metastasizing carcinoid at St Mark s Hospital (Gabriel and Morson 1956) This presented as a large ulcerating tumour of the upper third of the rectum (Fig 39) Rectal biopsy showed anaplastic features not seen in the ordinary submucosal variety and a radical operation was therefore carried out At laparotomy secondary deposits were found in the liver and there were lymphatic metastases in the operation specimen Histological sections of the tumour revealed some areas typical of the ileocaecal type of carcinoid together with cytoplasmic granules but others with appearances characteristic of the atypical rectal variety (Fig 40)

A study of metastasizing carcinoid of the rectum reported in the literature suggests that the size of the tumour the presence of ulceration and fixation are the main factors in any clinical assessment of the degree of malignancy Rectal biopsy may also be a guide to treatment

There has been no report in the literature of a metastasizing carcinoid of the rectum with clinical manifestations such as cutaneous flushing and diarrhoea due to the excess secretion of 5 hydroxytryptamine Urine tests for 5 hydroxy indole acetic acid were performed before and after removal of the primary growth in the St Mark s case of metastasizing carcinoid of the rectum referred to above, but the levels were normal and remained so until the patient died from liver metastases four years after operation It is probable that only the metastasizing carcinoids of the ileocaecal type which show considerable density of cytoplasmic granularity secrete enough 5 hydroxytryptamine to cause a rise above the normal blood level or give rise to clinical manifestations of the carcinoid syndrome

Colloid Carcinoma Arising Within Ano-rectal Fistulae

Dukes and Galvin (1956) reported several cases of colloid carcinoma aris

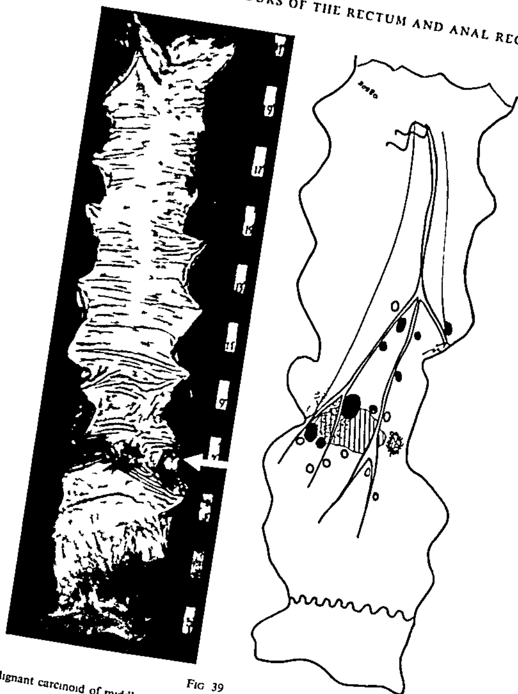


FIG 39

Malignant carcinoid of middle third of rectum The accompanying chart shows nine lymphatic metastases

ing within ano rectal fistulae in which no primary tumour was present in the rectum or anal canal They concluded from their study that the carcinoma in these cases had arisen from congenital ano rectal fistulae lined by rectal mucosa This is a very rare condition and it may cause considerable difficulties in clinical

diagnosis Such cases have to be differentiated from those in which a carcinoma of the lower rectum has spread into a pre existing fistula also from implantation of carcinoma cells in a pre existing fistula from a carcinoma of the sigmoid colon or recto sigmoid region

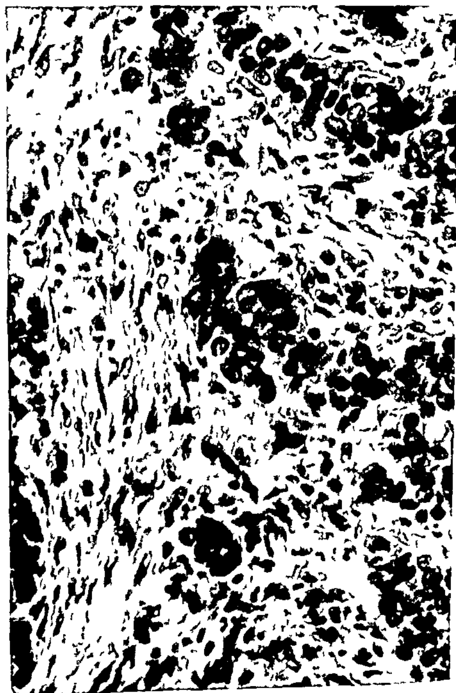


FIG 40

Malignant carcinoid of rectum Sections of the tumour showed that some of the cells contain the cytoplasmic granules typical of carcinoid The granules appear black in the photograph

Malignant Melanoma of the Anal Canal

During the years 1928–56 nine patients with malignant melanoma of the anal canal were seen at St Mark s Hospital This is an incidence of about 0 25 per cent of rectal adenocarcinomas and between 5 and 10 per cent of squamous cell carcinomas of the anus seen during the same period Two of these cases have been reported previously by Dukes and Bussey (1947) Malignant melan oma of the anal canal is therefore an extremely rare form of malignant disease It arises from the upper part of the anal canal but often presents clinically as a tumour of the lower rectum because of preferential upward spread Of the 9 St Mark s patients 5 were females and 4 were males Their average age was 55 7 years which is lower than the average age of the St Mark s cases of rectal cancer (60 4 years)

Malignant melanoma of the anal canal is invariably a protuberant type of tumour It usually presents either as a large polyp (Fig 41) in the lower third of the rectum or upper part of the anal canal or with the appearance of a black thrombosed internal haemorrhoid (Fig 42) All the tumours in the St Mark s series appear to have arisen from the region of the dentate line with preferential spread upwards into the lower third of the rectum This upward spread may be continuous or take the form of multiple submucous nodules Three of these tumours were obviously pigmented on clinical examination

Two of the nine cases in this series were inoperable at laparotomy owing to extensive intra abdominal metastases The other seven were treated by a radical operation and five of these had extensive haemorrhoidal lymph gland deposits in the operation specimen Three also had secondary deposits in the inguinal lymph glands these metastases occurring at a later stage of the disease

The prognosis of malignant melanoma of the anal canal is extremely poor Both the inoperable patients in the St Mark s series were dead within one year Of the 7 treated by radical excision of the rectum and anal canal one died of the operation 3 died within one year 2 within two years and one suvrived just over three years This last patient had no haemorrhoidal or inguinal lymph gland deposits at the time of operation

Malignant melanoma of this region should be classified with the melanomas of other juxta cutaneous mucous membranes such as those found in the con junctiva nose mouth and cervix It arises from melanoblastic epithelium in the upper anal canal or from mucosa in the lower third of the rectum which has undergone squamous metaplasia A minority of the primary tumours in the St Mark s series were melanotic However some of the amelanotic growths showed pigmentation in their lymphatic metastases

Rodent Ulcer

Rodent ulcer or basal cell carcinoma arises from the hair bearing peri anal skin and is a rare disease Only 9 cases have been seen at St Mark s Hospital during the period 1928–56 All these patients were men and their average age was 69 4 years According to Bunstock (1958) 47 cases have been described in



FIG 41

Amelanotic malignant melanoma of the anal canal presenting as a large polyp in the lower third of the rectum

the world literature with a ratio of 3 1 in favour of men and an average age of 64 6 years for women and 61 8 years for men

Six of the St Mark s tumours were small enough to be treated by local excision one was treated with radium and 2 by a radical operation These



FIG 42

Deeply pigmented melanoma of the anal canal arising from the level of the anal valves with upward spread into the lower third of the rectum There are also a number of deeply pigmented discrete submucous metastases This tumour presented clinically as a thrombosed internal haemorrhoid which was removed by local excision prior to a radical operation

2 cases were extensive tumours involving the anal sphincters with upward spread into the anal canal (Fig 43) None recurred locally but two of the patients subsequently developed rodent ulcers on the face



FIG 41

Amelanotic malignant melanoma of the anal canal presenting as a large polyp in the lower third of the rectum

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2 cases were extensive tumours involving the anal sphin... spread into the anal canal (Fig 43) None recurred local... patients subsequently developed rodent ulcers on the face

Rodent ulcer of the peri anal skin presents clinically either as a small indurated ulcer or as a superficial area of ulceration with a rather moth eaten appearance In either case biopsy will establish the diagnosis Manheim and Alexander (1955) report a basal cell carcinoma occurring in a fistula in ano



FIG 43

Rodent ulcer of peri anal skin with upward spread into the anal canal and destruction of the anal sphincters The ulcer has a rather typical moth-eaten appearance

Carcinoma of Peri anal Apocrine Glands

A number of cases of carcinoma of the peri anal apocrine glands have been reported in the literature (Pearson and McArt 1953 Bocian and Tuschka 1957, Rabson *et al* 1958) Some of these are examples of extra mammary Paget s disease of the peri anal skin with an underlying apocrine gland carcinoma of sweat gland type only one example of apocrine gland carcinoma has been seen at St Mark s Hospital (Thompson 1956) Clinically this tumour presented as a shallow ulcer at the anal margin with surrounding nodular hypertrophic skin (Fig 44) Although extra mammary Paget s disease of the peri anal skin may be associated with an underlying apocrine gland carcinoma similar clinical and pathological appearances may result from the downward spread of adeno carcinoma of the rectum beneath the peri anal skin

Malignant Tumours of Lymphoid Tissue

Lymphosarcoma of the rectum presents either as a solitary ulcer or as generalized overgrowth of the lymphoid follicles of the rectum colon and sometimes of the whole gastro intestinal tract

The solitary lymphosarcomatous ulcer of the rectum is a rare condition Only 3 such cases have been seen at St Mark s Hospital in the last 25 years In its gross appearance solitary lymphosarcoma may not differ from adenocar cinoma of the rectum but a diagnosis of a tumour of lymphoid tissue may be made by rectal biopsy A distinction has to be made between benign rectal lymphoma and lymphosarcoma and this may be extremely difficult especially if the lymphosarcoma is histologically well differentiated A search must also be made for enlarged lymph glands in the inguinal cervical and axillary regions

Lymphoma of the rectum is a small submucous tumour which is benign and appears to have no relationship to lymphosarcoma It is seldom more than one inch in diameter and is usually found in the lower third of the rectum The pathological and clinical evidence suggests that it is an inflammatory rather than a neoplastic condition (Morson 1959)

Generalized lymphosarcoma of the lymphoid follicles of the rectum presents as a diffuse intestinal polyposis which may involve the whole of the gastro intestinal tract and has to be distinguished clinically from familial adenomatosis Two cases of lymphosarcomatous polyposis have recently been seen at St Mark s Hospital One of these was a female patient aged 48 who had involvement of the whole of the colon rectum and the mesenteric glands with enlargement of the spleen Histologically the polyps were composed of typical lympho sarcomatous tissue of a fairly well differentiated type The patient was still alive and well two years after the diagnosis had been established by laparotomy and biopsy The second patient was a male aged 75 with lymphosarcomatous poly posis of the whole of the intestine from the duodenum to the anus (Fig 45) The polyps were composed of proliferating lymphoid tissue covered by attenuated mucosa (Fig 46) and the histological appearances suggested that the polyps were the result of malignant overgrowth of the intestinal lymphoid follicles



Fig 44

Carcinoma of peri anal apocrine glands presenting as extra mammary Paget's disease of the peri anal skin

The polyposis was complicated by sigmoid diverticulitis and a partial colectomy was therefore performed Eight months later he developed a secondary conjunctival deposit

Infiltration of the rectal wall in leukaemia has been described and it is



FIG 45

Lymphosarcomatous polyposis of th large intestine There is proliferation of the lymphoid follicles with the formation of polyps which vary from small dome shaped nodules to larger p dunculated tumours with a smooth surface

therefore important that all patients with lymphoid tumours of the rectum should have a total and differential white cell count Another rare tumour of the rectum which may be mentioned is reticulum cell sarcoma The cases seen at

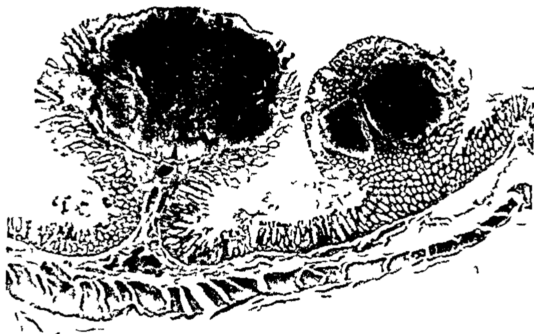


FIG 46

Lymphosarcomatous polyposis of the large intestine showing the proliferating lymphoid tissue covered by attenuated mucosa

St Mark s presented as ulcerating tumours indistinguishable clinically from carcinoma The prognosis in these cases was very poor

Leiomyosarcoma [Smooth Muscle Sarcoma]

Fourteen cases of leiomyosarcoma have been seen at St Mark s Hospital during the last 25 years Ten of these were males and 4 were females Their average age was about 58 years which is not significantly different from the average age of patients with adenocarcinoma of the rectum Ten of the 14 tumours were in the lower third of the rectum

Rectal leiomyosarcoma presents typically as a nodular and protuberant swelling which is partly covered by intact mucosa but shows central ulceration (Fig 47) It can be distinguished from carcinoma because it obviously arises from the deep tissues of the rectal wall Most of the St Mark s tumours were very large and microscopically consisted of interlacing bands of smooth muscle fibres which were well differentiated and histologically of a low grade of malignancy Extensive local spread into the peri rectal fat is characteristic of rectal leiomyosarcoma and this may make adequate resection difficult for the surgeon Local recurrence after excision of the rectum has occurred in a number of these cases

There were no lymphatic metastases in any of the twelve cases in the St



FIG 47

Leiomyosarcoma of the rectum Note the nodular and protuberant swelling within the rectum which is covered by intact mucosa apart from some central ulceration The extensive local spread into the extra rectal tissues is characteristic

Mark s series which were treated by a radical removal of the rectum This is not surprising for smooth muscle sarcomas do not usually metastasize to lymph glands unless they are very undifferentiated Apart from local recurrence metastasis to the liver and lungs was the commonest cause of death Three patients had liver secondaries at the time of operation One of these died in the post operative period but despite the liver metastases the other two lived for two and a half years and five years Two further patients both died of recurrence nearly 9 years after surgical removal of the primary tumour Despite the good 5 year survival rate the ultimate prognosis has been poor

Four out of the 14 cases in this series had had a local excision of the tumour

three to six years before radical treatment of a rectal recurrence at St Mark's Hospital. All the other tumours were very large and must have been present for some years. This long pre-operative period, taken in conjunction with the relatively long post-operative survival, confirms the histological observations that the tumours in the St Mark's series were all well differentiated and of a low grade of malignancy. However, they seem to have come to a radical excision too late in the course of their disease for hope of a permanent cure.

Leiomyosarcoma of the anal sphincter muscles occurs, and a peri-anal rhabdomyosarcoma (striped muscle sarcoma) has been described by Fisher and Gruhn (1958).

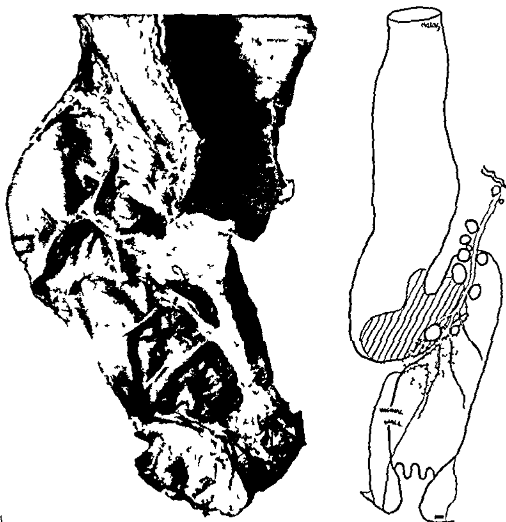


FIG 48

Carcinoma of the pelvic colon with prolapse into the recto-vesical pouch and secondary ulceration through the anterior rectal wall. There was considerable secondary infection of the tumour but no lymphatic metastasis.

Secondary Tumours of the Rectum

The commonest secondary tumour of the rectum is a carcinoma of the pelvic colon which has prolapsed into the pouch of Douglas or recto vesical pouch with secondary ulceration through the rectal wall (Fig 48) Such tumours are usually large of a low grade of malignancy and exhibit considerable secondary infection They may present with rectal rather than abdominal symptoms Secondary involvement of the rectum may also occur in carcinoma of the ovary, bladder and cervix

It is rare for prostatic carcinoma to present with rectal symptoms and only minimal urinary complaints Moreover it is uncommon for prostatic cancer to invade the rectal wall other than in advanced disease It is probable that the fascia of Denonvilliers provides an effective barrier to the backward spread of prostatic cancer but once this layer has been penetrated malignant cells may spread around the rectum and in particular within the submucous layer Sixteen cases of carcinoma of the prostate presenting clinically as disease of the rectum have been seen at St Mark s Hospital during the past 25 years (Davis 1960) These presented either as an anterior submucous mass as a tubular stricture of the rectum or in one case as a solitary rectal ulcer A correct diagnosis may be made by rectal biopsy in conjunction with a serum acid phosphatase test In rectal biopsy material the distinction between carcinoma of the prostate invading the rectum and primary anaplastic rectal carcinoma may not be easy The presence of large and prominent nucleoli in prostatic carcinoma cells is helpful in the differential diagnosis

Other tumours not primary neoplasms of the rectum which must be considered in the differential diagnosis of rectal malignancy include endometrioma haemangioma chordoma and pre sacral cysts Endometrioma presents as a hard mass in the rectum which may be confused with carcinoma The tumour is submucous and covered by intact mucous membrane A good account of rectal endometrioma has been given by Korn and Savage (1957) Haemangioma may be either circumscribed or diffuse (Gabriel 1949) It principally involves the rectal submucosa but may extend up into the sigmoid colon with angiomatous changes in the peri rectal fat and sigmoid mesentery The condition is a congenital malformation and not a neoplasm Chordoma is a malignant tumour of notochordal origin which may invade the rectal wall Reviews of the pathology of sacrococcygeal chordoma have been given by Stewart and Morin (1926) and Harvey and Dawson (1941)

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SECTION FOUR

CLINICAL FEATURES AND DIAGNOSIS OF RECTAL CANCER

CHAPTER IX

AGE, SEX AND SITE IN RELATION TO CANCER OF THE RECTUM

H J R BUSSEY and M H WALLACE

THE age and sex of patients influence the natural course of rectal cancer in a number of different ways some of which have long been known whereas others have only recently been established The greater incidence in males than in females is of course well known as is also the concentration of cases into the 50–70 year age group The tendency for the average age at diagnosis to be less in women than in men is also a familiar fact More recently the detailed study over a number of years of well documented series of cases of rectal cancer has revealed unsuspected correlations of age and sex with the extend of spread and ultimate prognosis (Dukes 1957) Evidence for this is provided by the series of cases from St Mark s Hospital comprising 4 435 patients treated in the 30 years 1928–57 These records form the basis of the following analysis

Sex Incidence of Rectal Cancer and Varying Relationship to Age

In the St Mark s Hospital series of the 4 435 cases of rectal cancer 2,925 (66 per cent) were males and 1 510 (34 per cent) females This gives an overall preponderance of men to women of nearly 2 1 which is similar though a little higher than that reported from other centres It is not generally recognized however that this proportion is not constant throughout all age groups but increases steadily from 30 years of age onwards as shown in the third column of Table IX These important differences in sex incidence are further emphasized if a correction factor is applied for the differing sex ratio at varying ages in the general population as has been done in column 4 This shows that below the age of 30 the incidence rate of rectal cancer among women is slightly higher than for men but over 30 years of age there is a progressive increase in the proportion of males until eventually at 80 and over they outnumber females by 4 1

Further differences are revealed by comparison of average ages and age distribution curves in the two sexes The average age of all cases in the St Mark s series was 60 38 years but the average for men (61 04 years) was nearly two years higher than the average for women (59 11 years) The range was from 17 years to 94 years The age distribution curves for the two sexes were similar except for a slight shift towards the left of that for females (Fig 49) This displacement of females towards the younger age groups and the slight preponderance of males in the older groups accounts for the difference of two years in the average ages of the sexes

TABLE IX

Relationship of Age to Sex in Cancer of the Rectum

Age Group (years)	1 Number of Males	2 Number of Females	3 Number of Males per 100 Females	4 Number of Males per 100 Females after correction for sex ratio in general population
Below 30	23	29	79	82
30–39	122	89	137	159
40–49	313	207	151	176
50–59	776	409	190	214
60–69	1055	477	221	257
70–79	568	270	210	287
80 and over	68	29	234	408

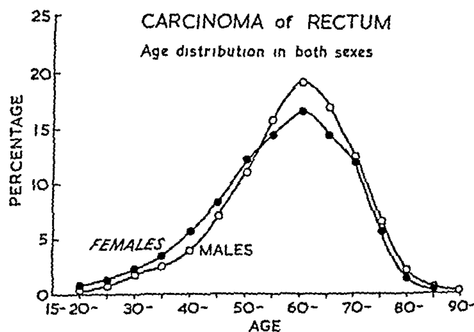


FIG 49

Examination of these graphs shows that the summit of the curve is at about 60 years of age and that nearly 65 per cent of the cases occur within ten years on each side of this peak This method of representation tends to obscure an important variation in incidence rate which becomes apparent when the numbers are charted as in Figure 50 after a correction has been made for the number of persons at risk in the different age groups throughout the general

population We now see that a rapid and continuous upward trend is present as far as the age of 75, particularly in the case of males The apparent fall thereafter is probably fictitious and due to the fact that this series of cases is based not on all recorded cases of rectal cancer as in the Registrar General s returns but on those seeking treatment at hospital

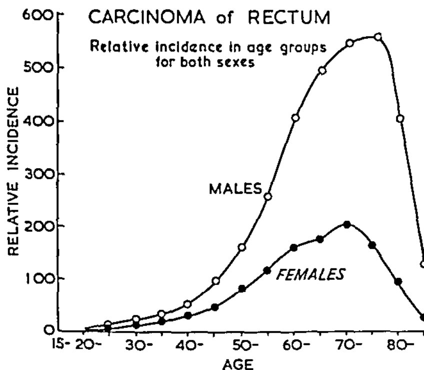


FIG 50

Influence of Precancerous Lesions on Average Age of Rectal Cancer

Familial intestinal polyposis and chronic ulcerative colitis are both recognized to be precancerous lesions and it is well known that when rectal or colon cancer follows it occurs at a younger age than in the general population For these reasons it is natural to ask how much of the cancer occurring in younger age groups is associated with these precancerous lesions The answer is not much because these intestinal diseases are relatively rare In the St Mark s series only 14 2 per cent of the cases under 30 years of age had associated polyposis or colitis the corresponding figure for those under 40 years being 5 3 per cent

Influence of Age of Patient on the Spread of Rectal Cancer

1 *Local Spread*

In the cases at St Mark s in which the growth had been removed by a major operation systematic observations were made in the Pathology Depart

ment to record the extent of spread of cancer by direct extension into the neigh bouring tissues, the following four groups being distinguished

1 Those in which the growth was confined to the bowel wall without extra rectal spread
2 Those in which there was slight spread *into the extra rectal tissues*
3 Those in which there was moderate spread with growth well established in the mesentery
4 Those in which there was extensive local spread *possibly into neigh bouring organs*

TABLE X

Relationship of Age to Extent of Direct Continuity Spread

	Males		*Females*	
	Number of cases	*Average age (years)*	*Number of cases*	*Average age (years*
No spread	274	62 8	186	61 6
Slight spread	482	62 1	257	58 8
Moderate spread	291	60 7	136	59 7
Extensive spread	538	59 5	331	59 5

The average age of patients in these four groups is recorded in Table X from which a rough general conclusion may be drawn that contrary to expec tations, *the younger the patient the deeper the invasion In other words in the* lower age groups carcinoma invades more rapidly than in the elderly This fact is seen from another angle if patients are grouped according to age and the pro portion of cases *with extensive local spread is recorded for each age group as* has been done in Table XI *From this it is apparent that there is a general ten* dency for the older age groups to have a smaller proportion of extensive spread growths , *this being particularly obvious in patients below the age of* 40 Con versely the A cases (those with local spread limited to the bowel wall and without lymphatic metastases) were much less frequent among the young than the old The graphic *representation of the* proportion of A B and C cases in each age group shows in a very convincing way that the relative *proportion* of both A and B cases tends to rise from *30 to 70 years of age whereas during the same* period there is a corresponding decrease in the proportion *of C cases* (Fig 51)

2 *Lymphatic Spread*

In the 2 950 cases of the St Mark's series submitted to major surgery for

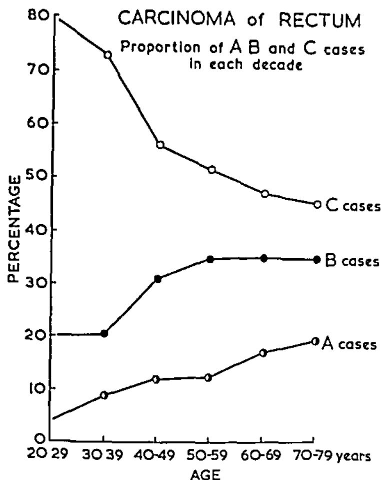


FIG 51

removal of the primary rectal growth and subsequently classified as A, B or C metastases were found in the regional lymph nodes in 1 509 cases or 51 2 per cent By subdividing these into males and females the proportions found were 49 2 per cent and 54 7 per cent respectively This difference between the in cidences of lymphatic metastases in the sexes remained constant throughout the whole period observed in spite of changing fashions in surgical procedure and is certainly of significance

The relationship of the age of the patient and the lymphatic spread of rectal cancer is shown clearly by charting the proportion of C cases in each age group as has been done in Figure 51 The figures for each age group in the whole series are recorded in Table XII In each decade from the twenties to the seventies there is a progressive decline in the proportion of cases with lymphatic metastases This is seen in both sexes though more marked in males (Table XII)

TABLE XI

Proportions of Growths with Extensive Spread in Various Age Groups

Age Group (years)	Proportion of total cases with extensive local spread		
	Males (per cent)	Females (per cent)	Total (per cent)
Below 30	60 0	58 3	59 1
30–39	52 3	40 0	47 3
40–49	38 2	36 1	37 3
50–59	40 7	37 2	35 0
60–69	32 5	33 1	32 7
70–79	30 7	37 6	33 3
80 & above	25 6	38 9	31 0

TABLE XII

Relationship of Lymphatic Metastases to Age

1928–57

Age Group (years)	Males		Females		Total	
	Number	Percentage with lymphatic metastases	Number	Percentage with lymphatic metastases	Number	Percentage with lymphatic metastases
Under 20	2	50 0	1	100 0	3	66 7
20–29	10	90 0	18	72 2	28	78 6
30–39	83	73 5	56	73 2	139	73 4
40–49	214	52 3	163	62 0	377	56 5
50–59	531	52 0	285	53 3	816	52 4
60–69	679	45 5	331	50 5	1010	47 1
70–79	334	42 8	184	50 0	518	45 4
80 and over	40	50 0	19	57 9	59	52 5
	1893		1057		2950	

3 *Venous Spread*

In the St Mark s series all specimens removed at operation were examined for macroscopic evidence of extension of the tumour along the veins This was found in 13 8 per cent of 167 patients below the age of 40, in 10 8 per cent of those aged 40–59 (1 193 cases) while 1,587 patients over 60 years of age showed a 10 3 per cent incidence of venous invasion The differences are slight as compared with local and lymphatic spread, but it seems as if venous spread also is liable to occur with greater frequency among the young than the old

Influence of Age on Liability to Multiple Malignancy

The presence of more than one malignant tumour in an operation specimen removed by rectal excision was observed in 7 6 per cent of the cases under the age of 40 but in only 3 8 per cent of those above this age The increase in multiple malignancy in younger persons is chiefly due to the two precancerous conditions polyposis and ulcerative colitis to which reference has already been made In both these conditions malignancy arises more commonly in younger patients and multiple foci of carcinoma are frequent It is not therefore surprising to find that of the 14 cases of multiple malignancy among the under 40 age group no less than 11 (80 per cent) had associated polyposis or colitis

Relation of Age of Patient and Histology of Rectal Cancer

The subdivision of adenocarcinoma of the rectum into three histological grades of malignancy as described in Chapter VI makes it possible to study the relationship between the age of the patient and the histology of the primary tumour Such an investigation shows at once that there is a tendency for patients in the younger age groups to have a higher proportion of growths of a high grade of malignancy and for a higher proportion of low malignancy tumours to be found amongst elderly patients Thus the proportion of high grade carcinoma was 52 8 per cent under the age of 30 years but fell progressively through all age groups to only 11 4 per cent of those 80 years old or over (Fig 52) This decline in high grade malignancy tumours with increasing age occurred in each sex though it was not so marked in women as in men

Another histological feature related to age is the property of mucus secretion Mucus can be demonstrated by special stains in most adenocarcinomas of the rectum but in only a small proportion is this an obvious feature in the sections So-called mucus secreting growths formed 10 6 per cent of the total carcinomas in the St Mark s series Subdivision into age groups showed however that the proportion was much increased in the cases below 40 years of age and particularly so in the youngest members of the series as recorded in Table XIII This striking increase in the incidence of mucus secreting adenocarcinoma of the rectum in young persons is found in both sexes and also agrees with similar findings in carcinoma of the colon (Chappell 1959)

Relation of Age and 5 year Survival

Before discussing the effect of age and site on survival of patients with rectal cancer it must first be pointed out that all survival rates quoted are for a period of 5 years from the time of treatment and are calculated for the cases treated from 1928 to 1952 The results have been corrected for age to allow for deaths from other causes *i e* they express the number of actual survivors as a percentage of those expected to be alive at the end of 5 years The necessity of this correction when comparing survival of young patients with that of old is obvious It is likewise just as important in making comparisons between the sexes for the expected survival of women is greater than that for men In the

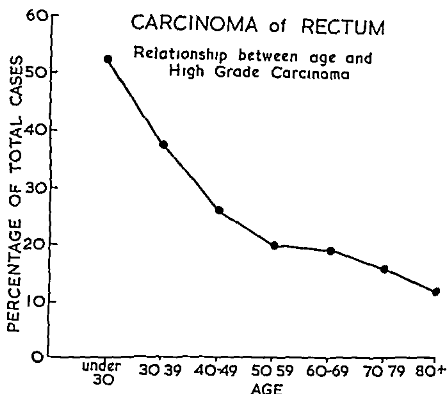


Fig 52

TABLE XIII

Relationship of Mucus Secretion to Age

Age	*Total number of cancers*	*Number of mucus secreting growths*	*Percentage*
Below 30	52	23	44 2
30–39	211	40	19 0
40–49	520	68	13 1
50–59	1185	117	9 9
60–69	1532	125	8 2
70–79	838	89	10 6
80 and over	97	10	10 3
Total	4435	472	10 6

present series the uncorrected overall 5 year survival taking into account deaths from *all* causes cancer, operation, other diseases and accident was 29 7 per cent for males and 34 1 per cent for females After correction for the expected survival of each sex the corresponding figures are 36 8 per cent and 38 9 per cent showing that there is little difference between the sexes in regard to survival

The corrected 5 year survival rate of patients with rectal carcinoma has been calculated for each 10 year age period and the results are recorded in Fig 53 Below 40 years of age the survival rate is 29 2 per cent For those below 30 years the prognosis is even poorer (20 7 per cent) The survival rate of those patients aged 40-80 years remains remarkably constant at about 40 0 per cent in the four decades From 80 years onward the survival is improved to about 74 per cent though the number of patients in this group is relatively small (57 cases) The poorer survival of the younger patients and the better prognosis in the elderly is in keeping with the varying proportion of low and high grade carcinomas in these groups

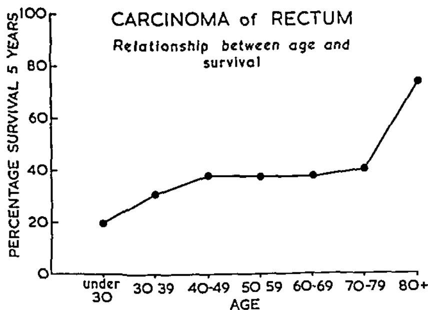


Fig 53

Influence of Site of Rectal Cancer on 5 year Survival Rate after Surgical Treatment

No significant differences were detected when the site of the growth was considered in relation to age and sex grade the extent of local spread or incidence of lymphatic metastases Nor was there at first sight any significant difference when comparisons were made in the survival rate of patients who had undergone excision of the rectum for growths situated in either the upper middle or lower thirds If however the series is broken up into the A B C grouping then differences in survival become apparent For instance the A cases had an average survival rate of 96 6 per cent but when comparisons were

made it was found that cases in the upper third of the rectum did not have so favourable a prognosis as lower third growths Conversely B cases in the upper third had a better survival than those in the lower third (81 1 per cent and 72 9 per cent respectively) Similarly the cancers with lymphatic involvement (C cases) had a survival rate of 36 0 per cent when occurring in the upper rectum and only 28 7 per cent when in the lower rectum The poorer prognosis in lower third growths with lymphatic metastases agrees with the observations of Gilchrist and David (1947–48) on the increased incidence of local recurrences after removal of these tumours It has often been suggested that lower rectal growths would have a worse prognosis than those in the upper rectum because of the possibility of lateral spread along the middle haemorrhoidal vessels and these figures provide some evidence for this in that they show a worse prognosis for B and C cases situated in the lower third of the rectum

It is clear that the exact site of a rectal cancer has some effect on prognosis after surgical excision, and this fact should be considered when comparing the results of different operations the choice of which may be determined by the site and type of growth to be removed

General Conclusions

Each of the methods of estimating the degree of malignancy of rectal cancer which have been used in this chapter such as histological appearance, rate of local spread extent of lymphatic and venous spread points to an increase in the malignancy of rectal carcinoma in younger age groups and this in turn is confirmed by their less favourable prognosis after surgical treatment In general it may be said that when rectal cancer develops before the age of 40 it spreads more rapidly and has a worse prognosis than when it occurs later in life Important differences have also been noted in the general pathology of the disease in the two sexes At the present time the main interest of these observations lies in the fact that they indicate that rectal cancers like other forms of malignant disease might in certain circumstances be influenced by hormone therapy

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CHAPTER X

ANATOMICAL AND PHYSIOLOGICAL CONSIDERATIONS IN RELATION TO OPERATIONS FOR RECTAL CANCER

ALAN PARKS

AN operation designed to eradicate cancer must be planned to remove as much tissue as possible around an organ without interfering with the function of adjacent structures After abdomino perineal resection of the rectum the genito urinary tract is almost all that remains in the pelvis it is highly desirable that micturition should be unimpaired even if sexual function is sacrificed Following conservative resection normal defaecation will depend on the sensitivity of the rectal stump and it is essential that this has sufficient innervation to allow a normal defaecation reflex to take place

ANATOMICAL CONSIDERATIONS

The Pelvis

The pelvis may be likened to a cylindrical box directed at an angle of about 35° to the main axis of the abdominal cavity Anteriorly the box is filled with the genito urinary apparatus posteriorly the rectum takes up most of the free space If the rectum were a straight tube there would be room on either side for connective tissue but the rectum belies its name and takes a curved or sinuous course thereby filling more of the cavity than would be expected The bottom of the pelvic cavity is closed by the muscular floor which is deficient only at the points where the viscera pass on through to the perineum In performing operations for excision of the rectum the pelvic box may be emptied from above or from below Whichever approach is adopted the end distal to the operator is often difficult to deal with It is therefore easier to empty it by approaching from both ends and this is particularly true in the male patient

It is usually easier to perform pelvic operations in the female chiefly because the cavity is broader but also because the uterus and vagina act as a barrier shielding or protecting the bladder If the tumour is situated in the anterior rectal quadrant the vagina and uterus must both be sacrificed if a radical operation is performed The corresponding organs of the male the prostate and vesicles are smaller and cannot be separated from bladder and urethra It is therefore impossible to perform a truly radical operation for an anterior penetrating rectal carcinoma in a man without removing some parts of the lower urinary tract also a sacrifice which few consider justified

The Pelvic Colon and Rectum

In early embryonic life the entire large bowel is suspended on a mesentery. Following rotation of the mid gut loop the colon occupies the outer margin of the abdominal cavity and lies immediately in front of the posterior abdominal wall. The mesentery of the ascending and descending parts is in direct contact with the peritoneum of the posterior abdominal wall. As intra uterine growth proceeds these two layers fuse and now the anterior peritoneal covering of the meso colon becomes the posterior abdominal peritoneum. In this way both ascending and descending parts of the colon become partially extra peritoneal. This process does not affect the transverse or pelvic colons. The line of fusion between visceral and somatic structures is still a cleavage plane in adult life and few vessels pass from the mesentery to the posterior abdominal wall. It is a natural plane of dissection so that the mesenteric vessels are readily separated from the structures on the posterior abdominal wall (ureter and gonadal vessels) which are so close. In the left iliac fossa the colon obtains a complete peritoneal coat and becomes the pelvic iliac or sigmoid colon. Even in this region, however there may be patches of adherence between mesentery and the parietal peritoneum. Whitish fibrous tissue is found at these points, and it is important that this be recognized at operation and divided during the initial dissection when freeing the pelvic colon. If this precaution is not taken a deeper plane of dissection might be chosen resulting in damage to the ureter.

The base of the mesentery of the pelvic colon crosses the pelvic brim over the sacro iliac joint to become the upper part of the meso rectum. During this part of its course there are several important structures posteriorly including the ureter and the bifurcation of the common iliac vessels. Dissection in the plane of peritoneal fusion will separate them quite easily despite their close proximity. Towards the end of the pelvic loop the mesentery shortens and the gut becomes that part commonly known as the recto sigmoid.

Because the rectum is a partially telescoped tube and because of its distensibility it is difficult to be precise about the familiar anatomical landmarks or about exact measurements. The rectum is often divided for descriptive purposes into three parts the first below the peritoneal reflection at the pouch of Douglas the second between the peritoneal reflection and the region where the rectum obtains a peritoneal coat on anterior and lateral surfaces and the third between this point and the origin of a true mesentery. This is only a rough method of subdivision because the depth of the pelvic cavity varies greatly from person to person and occasionally a mesentery may continue downwards as far as the upper part of the anal canal.

The rectum passes down through the pelvis in concertina like fashion the spur on the inner side of each of its curves forming one of the valves of Houston. There are usually three curves two to the right and one to the left. The upper third of the rectum is covered with peritoneum on all sides except that abutting on the sacrum. The convexity of its curvature is first directed to the right but in descending a curve develops in the opposite direction and gradually the bowel

loses its peritoneal cover until it disappears beneath the peritoneum at the bottom of the pouch of Douglas

The upper third is related anteriorly through the pouch of Douglas with the uterus in the female or bladder in the male Posteriorly is fatty areolar tissue which is sometimes called the meso rectum it contains the superior haemorrhoidal vessels and lies in front of the middle sacral vessels which may take the form of a large plexus of dilated friable veins The hypogastric plexus of nerves also lies deep to the upper part of the meso rectum It divides into its two parts which pass laterally on either side of the bowel to the bladder and is liable to be removed with the rectum unless care is taken to preserve it

The lower third of the rectum is straighter because the pelvic box is narrowed by the funnel shaped sheet of levator ani muscles Anteriorly the longitudinal muscle of the rectum is immediately adjacent to the vaginal wall or the prostate and vesicles Between the capsule of the prostate and the longitudinal muscle is a thin layer of tissue Denonvilliers fascia this is supposed to represent an obliterated peritoneal pouch which formerly extended in the embryo to the apex of the prostate It is of some practical importance because it is a plane of cleavage which separates readily during dissection

Posteriorly the rectal ampulla rests on Waldeyer s fascia a sheet of connective tissue arising from the front of the sacrum and the fascia of the adjoining pelvic wall It fuses with the fascia propria of the rectum just above the ano rectal ring It separates the rectal ampulla from the plexus of veins on the lower sacrum and also from the lower branches of the sacral nerves The fascia propria of the rectum is a tenuous layer of areolar tissue enclosing the rectum and its surrounding fat separating it from the para rectal connective tissue

On either side of the ampulla of the rectum lying chiefly in the sulcus between it and the vagina or prostate is a network of para rectal connective tissue through which pass branches of the internal iliac artery the middle rectal vessels During excision of the rectum these pads of fat and vessels are isolated from the structures in front and behind by dissection anterior and posterior to the bowel In this way the so called lateral ligaments are isolated In operations for cancer of the ampulla it is desirable to divide these as close to the pelvic wall as possible

At the upper border of the ligaments three structures are found which should not be damaged The ureter having swept over the side wall of the pelvis swings towards the midline in its course to the bladder passes just anterior to the lateral ligament and is liable to damage especially if distorted by traction on the ligament from below Branches of the internal iliac artery are also liable to be drawn down by traction on the lateral ligaments and they bleed alarmingly if divided Finally the hypogastric nerves pass just above the ligament on its course to the bladder Insufficient care in dissection may result in damage to one or all of these structures

There are thus two regions where the ureter is liable to injury firstly at the pelvic brim if it is pulled up into the pelvic mesocolon secondly in front of the lateral ligament just before it passes into the bladder In the female the ureter is more easily avoided because it is situated in the broad ligament which is usually retracted forwards out of harm s way When simultaneous hysterectomy is

necessary, however, the ureter is imperilled where it is crossed by the uterine arteries close to the cervix, and therefore the lower three inches of each ureter must be carefully identified However, they must not be dissected completely free of adjacent tissue lest they should slough due to loss of blood supply

The pelvic floor has two components, somatic and visceral The alimentary and genito urinary viscera pass through the pelvic hiatus on their way to the exterior They possess their own muscle coat but as this consists of smooth involuntary fibres they have no mechanism for preserving control over the perineal orifices For this reason the somatic muscles which close the whole of the pelvic floor are especially well developed centrally, forming sphincters which provide effective control over the termination of the rectum and anus The somatic muscles form a funnel the narrow portion of which encircles the viscera lateral to which the fat of the ischio rectal fossa is found The visceral musculature is supplied by autonomic fibres via the hypogastric nerves The somatic sheet of muscles has a double innervation the levator ani being supplied by branches of the sacral plexus, whereas the external sphincter and pubo rectalis receive their innervation from the pudenal nerve (see Figs 54-57)

When approaching the pelvis from the perineum the first sheet of muscles to be encountered by the surgeon is the superficial lamina comprising the subcutaneous part of the external sphincter ani the transverse perinei and the bulbo and ischio cavernosus muscles Fibres of all these muscles intersect at a focal point anterior to the anal canal There is considerable variation in the arrangement of the fibres of the lower part of the external sphincter, some arise from the recto anal dermis, others may have attachment to the coccyx The deep part of the external sphincter is a band about a quarter of an inch in diameter continuous above with the pubo rectalis from which it cannot be separated The latter muscle is usually the best developed of all the pelvic floor muscles because not only does it support most of the contents of the pelvis but it also acts as a strong anal sphincter by drawing the anal canal forwards It accounts for the sharp angulation between the axis of the anal canal and the rectal ampulla which on digital examination is felt as a ridge, the ano rectal ring The pubo coccygeus is continuous with the pubo rectalis above It also can help to close the pelvis hiatus but is inefficient as a sphincter The ilio coccygeus fans out laterally to close the gap between the obturator internus and the sacrum and is the least well developed of the muscles of the pelvic floor

At excision operations the last three of these muscles have to be divided in order to free the anal canal during the initial part of the perineal dissection There is still another funnel shaped attachment of the upper anal canal to the side wall of the pelvis namely Waldeyer s fascia which arises from the front of the sacrum and is inserted into the longitudinal muscle of the upper part of the anal canal As this layer is traced forwards it becomes muscular and constitutes a strong band of muscle near the midline anteriorly The part which runs from the pubic arch to be inserted into the anal canal is rightly called the upper lamella of the levator ani It is sometimes incorrectly called the pubo rectalis or even the recto urethralis because some fibres are attached to the urethra This is the highest structure which has to be divided from below before the space of

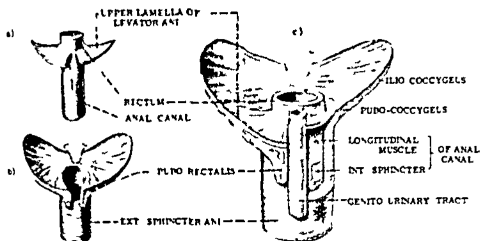


Fig 54

To illustrate the muscular arrangements of the pelvic floor and anal canal (a) Shows the visceral component with attached upper lamella of the levator ani (b) demonstrates the somatic component Fusion of the two produces the final form as seen in (c)

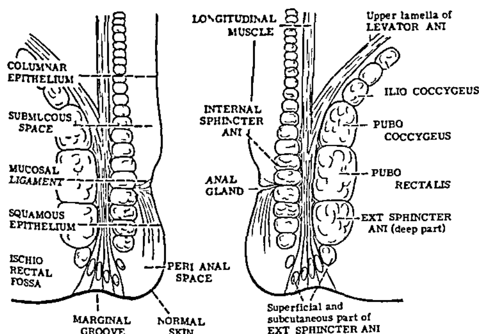


Fig 55

A diagrammatic coronal section through the anal canal

Denonvilliers is encountered Traction on the rectum causes deformation of for muscle so that its fibres run parallel with the bowel If they are then mistaken the the longitudinal fibres of the anal canal the operator may dissect too far anteriorly and (in the male) may injure the urethra If, on the other hand the operator dissects at right angles to the fibres he may open into the rectum

Blood Supply

The general vascular arrangements of the colon are too well known to

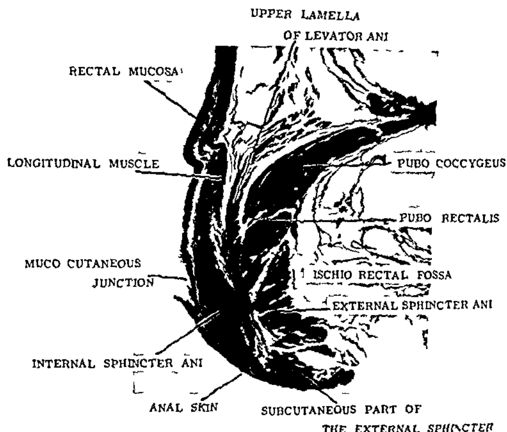


Fig 56

A coronal section through the pelvic floor and anal canal Thick section cut at 200μ

require description here The colon differs from the small bowel in possessing a marginal artery and whereas the terminal branches of the enteric arteries are *end arteries this is not true of the colonic vessels This is of great importance* for the surgeon because it means that when he has to sacrifice the main artery to a segment of the colon he can usually rely on the marginal vessel to bring an adequate supply from the neighbouring bowel It is possible to inject the ileo-colic artery *in vitro* and obtain a flow of the perfusing *fluid from the marginal vessel of the pelvic colon* all other vessels having been tied This is not to affirm that an adequate blood supply would be present *in vivo* to nourish an anastomosis at such a distance However, in practice, it is usually safe if one of the main arteries, for instance the left colic is divided Anatomical *variation may*

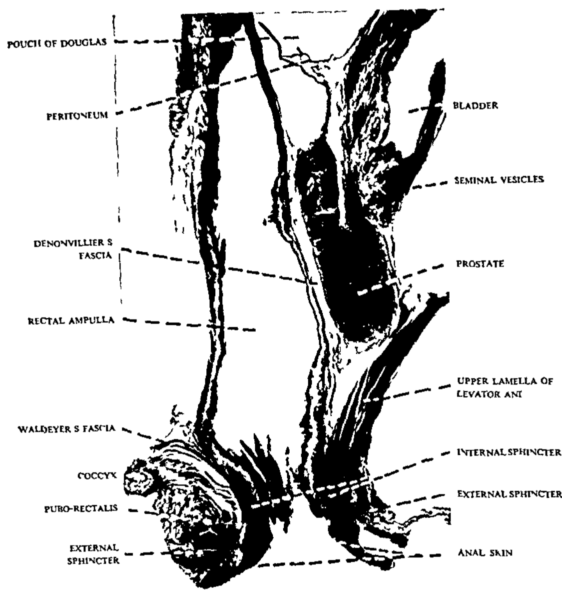


FIG 57

A sagittal section through a male pelvis Note the relationship of the prostate and rectum with intervening Denonvillier s fascia

modify this generalization and it is important at operation to survey the arterial supply to the bowel before dividing any one branch The marginal artery tends to be less well developed in the transverse colon and especially at the splenic flexure For this reason ligation of the middle colic artery is often followed by necrosis of the transverse colon Care must be exercised to leave an arterial arcade in the mesentery of the splenic flexure if this is mobilized to bring the descending colon down for the purpose of anastomosis Branches of the mar

ginal artery pierce the muscle coats of the bowel and enter the submucous plexus This plexus varies in the different regions of the colon but from the transverse to the end of the pelvic loop it is a fine reticular network which is not capable of nourishing the bowel wall for more than 1 to 2 cms beyond an entering artery In the rectum the submucous plexus becomes denser and the vessels are of greater diameter In the ampulla itself the submucosa is traversed by the terminal branches of the superior haemorrhoidal artery which run longitudinally for 2 to 3 inches ending just above the muco cutaneous junction The middle rectal arteries usually deliver a large blood flow to the rectal ampulla by anas tomosing with the terminal branches of the superior haemorrhoidal vessels When the lateral ligaments of the rectum are divided the middle rectal vessels bleed briskly and must be ligated Another supply comes to the anal canal and lower rectum by anastomotic channels across the anal sphincters from the pudenal vessels This is usually adequate to nourish a rectal stump even though the middle rectal arteries have been ligated

Physiological Considerations

Operations for the cure of cancer must be radical of necessity but even so it is desirable that they should interfere with normal physiological functions as little as possible When an operation is only palliative it is even more important that the function of the parts remaining should be as nearly perfect as possible *Almost all the difficulties arising after excision of the rectum are due to the* denervation of the visceral structures Impaired control of defaecation and micturition together with disturbance of sexual function constitute the chief problems It is therefore necessary to consider the innervation of the region first

Innervation

As previously noted pelvic structures may be divided into two parts somatic and visceral The somatic group is made up of the voluntary muscles of the pelvic floor together with the adjoining connective tissue the perineal skin and the lower half of the mucosa of the anal canal The innervation of this region is mediated by somatic nerves The visceral components of the pelvis receive only sympathetic and para sympathetic nerves and it is these which are particularly liable to injury during operations for cure of rectal cancer

Sympathetic nerve fibres arising in the first and second lumbar sympathetic ganglia pass downwards and form the hypogastric nerve which lies in front of the first sacral vertebra behind the meso rectum The nerve divides into two parts which pass forwards and downwards outside the fascia propria of the third part of the rectum At the level of the peritoneal reflection they break up into a plexus and are joined by the sacral para sympathetic outflow From here branches of both groups of nerves supply the lower pelvic viscera The para sympathetic fibres arise from the second third and fourth sacral roots and must penetrate Waldeyer s fascia before passing to the pelvic plexus in the upper part

of the lateral ligaments If Waldeyer s fascia is stripped off the sacrum these nerves will be avulsed from the sacral foramina

It is possible to identify both sets of nerves and the pelvic plexus at operation The hypogastric nerve is first found on the sacral prominence behind the meso rectum The right or left branch is traced downwards and can be separated laterally off the fascia propria recti by gentle sponge dissection The nerve can be followed to the pelvic plexus situated in the upper part of the lateral ligament into which the nervi erigentes can also be seen entering (Fig 58) It is possible to excise the plexus completely if the lateral ligaments are divided flush with the side wall of the pelvis It is important that the perineal operator should not strip up Waldeyer s fascia to the point where the para sympathetic nerves enter it to preserve them the fascia should be severed within an inch of its insertion into the upper part of the anal canal

Defaecation

Following operations for carcinoma of the rectum in which the pelvic sphincters have been preserved the ability of patients to defaecate may vary from normal function on the one hand to incontinence on the other The functional result will depend on the extent of damage to the neuro muscular mechanism controlling the pelvic floor

Delivery of faeces to the rectal ampulla excites sensory receptors in the mucosa or muscle wall (the exact location of these end organs is unknown) Afferent impulses pass upwards through the spinal centres to the cerebral cortex and set up the awareness of the presence of faeces in the rectum If this is ignored further distension of the rectum may not produce a reaction in consciousness and an overloaded rectum may result without the subject being aware of it At the same time as the conscious response a local spinal reflex is set in action which causes relaxation of the external and internal sphincters of the anal canal This may allow faeces to enter the upper part of the anal canal and if the subject wishes defaecation will ensue Normally the reflex mechanism is facilitated by a voluntary action willed abdominal straining causes further relaxation of the external sphincter These reactions are well seen if the activity of the external sphincter is recorded by means of electromyography Normally the external sphincter is in a state of constant contraction this is almost unique as all other muscles except those of the face are electrically inactive at rest

If the subject does not wish to defaecate he can control the reflex mechanism by voluntary contraction of his external sphincter This causes reflex relaxation of the tension in the wall of the rectal ampulla and the mechanism is temporarily abated However fatigue of the external sphincter sets in within a minute and the muscle returns to its basal tone If the subject has diarrhoea and the rectum is being rapidly filled with liquid faeces the reflex call may be so strong that voluntary contraction of the muscles is ineffectual

Faeces in the anal canal itself particularly the lower half in the region of the anal papillae set up conscious sensation mediated through somatic not visceral nerves Hence this sensation is much more acute and urgent than the vaguer feelings mediated by the autonomic nervous system



Fig 58

Photograph of a pelvis dissected to demonstrate the autonomic innervation of the bladder and rectum

The patient who has had a low conservative resection of the rectum still has his somatic innervation intact so that he will be aware of faeces in the anal canal If however, less than 2 inches of the rectal ampulla has been retained he may have lost all sensation of filling of the terminal part of the bowel His first indication of bowel activity may then be caused by material in the anal canal and this will probably be too late for him to maintain continence voluntarily This particularly applies when the faeces are fluid or semi fluid If the bowel is constantly constipated it may only act once a day and even though he should have what is virtually a perineal colostomy, it will not be a great nuisance to him

Diminished rectal in contrast to anal sensation may be due either to excision of too much of the ampulla or damage to the nerves supplying it The sensory pathways from this region probably pass through the para sympathetic nerves which may be injured in a radical dissection of the lateral ligaments There is some evidence that posterior mobilization of the rectum may damage its nerve supply and it is important therefore that dissection in the plane behind the rectum be kept to a minimum Anal sensation alone seems to be inadequate to establish continence except perhaps in a persistently constipated patient It is therefore important to leave the terminal 2–3 inches of the rectum intact together with its autonomic innervation

Micturition

As with defaecation normal bladder function depends upon a complex neural mechanism The sacral para sympathetic outflow seems to be the more important and it contains both sensory and motor pathways Damage to this nervous pathway is usually caused by severing the lateral ligaments close to the pelvic wall This is particularly likely to happen in the male because the narrow pelvis allows only short lateral ligaments The broader pelvis of the female results in longer ligaments and they are not usually incised so close to the pelvic wall When combining excision of the rectum with hysterectomy however damage to the nerves is much more likely to occur with consequent bladder dysfunction

Cancer of the rectum is commonest in the age group in which benign prostatic hypertrophy is prone to occur If partial bladder neck obstruction is already present even mild injury to bladder innervation may induce permanent retention of urine In these circumstances normal function cannot be re established without prostatectomy usually a transurethral resection suffices After excision of the rectum the bladder may fall back into the space so created producing a greater angulation of the prostatic urethra with the bladder cavity than normal and may precipitate retention of urine by a mechanism similar to the median bar This type of difficulty is also overcome by a transurethral resection of the bladder neck

It is probable that the early delay in the establishment of micturition is due to temporary nervous dysfunction from operative trauma After ten days this has disappeared and the bladder functions normally If the nerve damage is more severe bladder sensation may be permanently abolished In the most

severe type of damage both motor and sensory mechanisms are lost Some spontaneous bladder contraction may return after a time but it *seldom results in* complete emptying and it is usually involuntary Sometimes it is possible to induce satisfactory emptying by means of intermittent strong suprapubic pressure on the fundus of the bladder

Sexual Function

In male patients the degree of interference with sexual function is *difficult* to assess because in many it has already ceased on account of age Erection is a vascular phenomenon due to dilatation of the penile arteries induced by stimulation of the pelvic para sympathetic outflow, the nervi erigentes Sympathetic nerve activity causes constriction of the penile arteries and subsidence of erection Ejaculation consists of the emission of semen as the result of contraction of the smooth muscle of the internal genital organs and also of the somatic muscle of the bulbo cavernosus This complex act therefore requires psychical initiation acting through the pelvic splanchnic nerves and a reflex arc mechanism comprising sensory receptors in the genitalia an afferent path through the pudendal nerves and an efferent pathway in the autonomic nervous system It is manifest that this may be interrupted in any of these situations The only way to minimize the incidence of impotence is to keep the dissection close to the longitudinal muscle coat of the rectum This is not possible in operations for cancer but for benign conditions such as ulcerative colitis and polyposis it is vital in order to inflict the minimum mutilation on the patient No precise statistics are available but it is probable that half of all male patients having abdomino perineal excisions are rendered impotent, whereas only about a fifth are so effected after conservative resections

Division of the pre sacral sympathetic nerve or of both its branches may allow reflux of ejaculate into the bladder owing to relaxation of the internal urethral sphincter this of course, results in sterility Little is known about the effect of these operations in the female but it is probable that orgasm is abolished in most

In conclusion it must be emphasized that our knowledge concerning the physiology of the pelvic viscera is inadequate and that further research into their abnormal activity should be most rewarding

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CHAPTER XI

THE CLINICAL DIAGNOSIS OF RECTAL CANCER

E G MUIR

History and Clinical Signs

GREAT importance is to be attached to a patient s story for the manner of its telling and the answers to pertinent questions may raise a suspicion which goes far towards making the diagnosis Some change in bowel habit and the passage of blood are by far the most common signs of rectal cancer Unfortunately not all patients are regular and an insidious change may not be appreciated or attributed to dietary excesses while the passage of blood may have occurred occasionally in the past through haemorrhoids and may be ignored

Duration of Symptoms

In a personal series of 417 cases (Muir 1956) the average duration of symptoms before diagnosis was 5 5 months and Yeomans (1936) from a larger number gave 6 months for males and 7–8 months for females Some of this delay may be due to the patient s ignorance or reluctance to seek advice, some to the practitioner s neglect to perform a rectal examination and some to an incomplete examination or the acceptance of another finding such as haemorrhoids or fissure as the cause of the symptoms If a practitioner always performed a rectal examination for rectal complaints many cases of rectal cancer would be diagnosed earlier and more would be resectable with chance of cure but it could also be argued that every case of rectal bleeding requires hospital investigation and that time would be saved if such patients were at once referred to an out patient department Whatever the results in practice the principle of this latter course must surely be wrong If the practitioner carries out a rectal examination as undoubtedly he should it must be appreciated that although some 70 per cent of rectal growths are palpable to the finger of an expert they can be missed by the inexperienced and only a full investigation can exclude the possibility

Alteration of Bowel Habit

Some complaint of an alteration in bowel habit was present in 81 per cent of my patients Over half (54 per cent) had noticed increasing frequency of stool 31 per cent complained of constipation and a large number had noticed both constipation and diarrhoea often alternating Other common symptoms are an increase required in the usual aperient an urgent desire to defaecate on rising the morning diarrhoea or a feeling of incomplete defaecation It must

also be admitted that a small rectal growth may remain symptomless and be detected only on a routine rectal examination

Bleeding The Passage of Mucus

Bleeding is the most common single complaint (66 per cent) The blood may be bright or dark occasionally as small clots and especially when the growth is papilliferous or villous mixed with mucus or slime The passage of mucus alone may be noticed by the patient

Loss of Weight

It does not seem reasonable that loss of weight should occur with rectal carcinoma except in the later stages but this was given as a complaint in 28 per cent of my patients It was naturally more common with advanced growths

Pain

Pain usually indicates an advanced growth though it is a much earlier symptom if the growth is in the ano-rectal region It may be anal in the sacro cocygeal region or in the lower abdomen and then sometimes associated with borborygmi and a relationship to meals

Other symptoms which may be present are tenesmus the passage of much wind with a loose stool anorexia nausea and a sense of distension and sometimes the actual prolapse of the growth A small number of patients and then almost invariably those with recto sigmoid growths do not reach hospital until complete intestinal obstruction is present

Carcinoma of the rectum may present as an unexpected finding in a chronic fissure or rarely in a fistula where colloid carcinoma appears unusually common and this possibility gives added force to the necessity for biopsy of any suspicious lesion It may also be discovered in the investigation of ulcerative colitis familial polyposis or the biopsy of a supposed innocent tumour

THE EXAMINATION OF THE PATIENT

The Abdomen

A full and careful examination of the abdomen is essential in any patient with bowel symptoms Distension or ascites increased borborygmi or the presence of abdominal masses are occasionally present when the patient first seeks advice A palpable and enlarged colon in the left iliac fossa or suprapubic region is frequently present above a constricting growth and clinically may be mistaken for another carcinoma in this site It is a significant finding for it indicates a degree of obstruction which may influence the operative procedure particularly if an anterior resection is subsequently to be considered

A palpable liver edge in a thin subject does not necessarily indicate metastases in others the hepatic enlargement with palpable nodules may be all too evident Examinations of the supraclavicular regions and the groins must not be omitted The inguinal glands are often palpable in a thin patient but when

a rectal growth involves the anal canal they may become enlarged and eventually acquire the characteristic hardness of malignant disease

Any patient who faces a major abdominal operation requires a careful general examination Some of this may be made at the first consultation, some requires investigation and the assessment of an experienced anaesthetist General nutrition and signs of weight loss a clinical impression of anaemia (often quite erroneous), the presence of a productive cough and the respiratory excursion the condition of the pulse and blood pressure are all observations which can be made in the consulting room and some of which may follow rather than precede the discovery of a rectal growth

Examination of the Rectum

This may be carried out with the patient lying in the left lateral or right lateral position Those who advocate the latter hold that a recto sigmoid growth may fall away in the left lateral position and become impalpable and that the left index finger can be trained by experience to become as receptive as the right Probably the majority of us who are right handed prefer the left lateral and become so accustomed to it that examination in the opposite position gives a sense of disorientation even in the rectum

If it is true that the majority of rectal growths can be felt with the finger this also depends both on the experience of the observer and the physique of the patient In a stout man with heavy buttocks digital penetration of even the whole of the anal canal may be difficult and this is but another reason why a sigmoidoscope should always be readily available

The typical rectal cancer is a lesion raised above the surrounding mucosa with an ulcerated centre and a raised everted indurated edge but the ulcer may be small and invasive or the tumour large and projecting into the lumen of the bowel In its early stages it may appear as a flattened slightly raised button in the mucosa without ulceration or as a small papilliferous growth with just a suggestion of induration around its base It is accepted that a considerable proportion of large bowel cancers develop in a previously innocent tumour and the first clinical indication of change is a sense of hardness in the base An early growth feels to the finger as if it and its surrounding mucosa were loose on the rectal wall later it is evident that the growth and the wall move together and in the more advanced cases the growth has fixed the rectum to surrounding structures and it has lost its mobility A growth in the recto sigmoid region just out of reach of the finger may be palpable through the anterior rectal wall Such a growth tends to descend when it has begun to constrict the lumen being pushed down by the efforts of the bowel above and it projects into the rectal ampulla like the cervix uteri The impression may be given that the lumen of the bowel passes up to one side of the mass but in fact the cervix is usually covered by normal mucosa and in its centre is the ulcerated growth surrounding the narrowed lumen Like cancer in other sites in some cases there may be little projecting tumour but considerable submucous spread almost like the linitis plastica of the stomach

In addition to the diagnosis of a rectal growth its operability will be

assessed, whether mucosa alone is involved an A case, whether the growth and rectum are mobile their mobility impaired or completely fixed Depending on its site the growth may involve the posterior vaginal wall the prostate vesicles or bladder or become fixed to the sacrum Glands may be palpable in the mesorectum or induration and thickening in the lateral ligaments possibly inflammatory may fix the growth to the side walls of the pelvis In a woman with an anterior rectal growth a vaginal examination should always be made to determine its attachment Thickening in the Pouch of Douglas may be an indication of peritoneal invasion and whenever possible an attempt should be made at a bimanual examination The position of the growth should be assessed in relationship to landmarks such as the cervix uteri the prostate and vesicles for though the final decision as to the type of operation to be performed can only be made in many cases at laparotomy a great deal will be learnt from digital examination

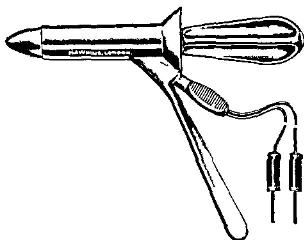


FIG 59
St Marks Hospital Proctoscope

Proctoscopy

After the digital examination an attempt must be made to inspect the growth by endoscopy and to confirm the diagnosis by biopsy It is unnecessary to add that the proctoscope and sigmoidoscope are to be used not only to confirm a diagnosis but to make one

The essentials of a good proctoscope are that its lumen should be sufficiently large to give the observer a view that it should be sufficiently long to traverse the anal canal and that it should be so shaped with its obturator that it can be passed into the rectum with the minimum of discomfort Once pain has been inflicted on a nervous patient future examination becomes much more difficult There are a number of excellent proctoscopes but for general purposes the simple tubular ones without a slide are the best (Fig 59) Some have a light attachment in the handle but an equally convenient illumination is from an adjustable light on a stand such as the Anglepoise

Proctoscopy should be performed after the digital examination with the patient in the left lateral position. If there has been any anal tenderness or spasm the preliminary introduction of a little Xylocaine Gel and the statement to the patient that a local anaesthetic has been inserted may be useful. The left lateral position may give all the information required but if a good view is not obtained and the lesion is within procotoscopic reach the patient should be placed in the knee chest elbow position with the thighs at not less than 90° to the couch and the back hollowed. This is sometimes thought to be an undignified and uncomfortable position for the patient and exhausting for the obese or frail but it permits the contents of the pelvis to fall upwards into the abdominal cavity and with the introduction of a hollow instrument the rectum fills with air and its walls fall apart. The view obtained is better than with the left lateral position. The jack-knife position on a special couch also gives a good view but is seldom used in this country.

Proctoscopy should enable the surgeon to see a growth in the rectal ampulla and to remove a piece for biopsy; above this level it is seldom adequate. Just as the growth may be too high it may occasionally be too low. A growth involving the anal canal may be difficult to visualize partly by reason of anal spasm and pain or because the proctoscope tends to ride beyond it at one stage and at the next is within the anal canal. Because of the patient's discomfort in such cases it may not be possible to carry out a full examination without an anaesthetic.

Sigmoidoscopy

Sigmoidoscopy should first be attempted in the left lateral position but changed to the knee chest elbow if there is any difficulty. Although sigmoidoscopy in an unprepared patient may sometimes be a failure much may be learnt from the attempt and in fact the first sigmoidoscopy should always be performed without preparation; an anaesthetic is not only unnecessary but undesirable. Blood may be seen in the lumen though there is no rectal growth and this indication of a possible lesion beyond the reach of the instrument might be missed if the patient has had a bowel washout before the sigmoidoscopy. If faeces obscure the view and cannot be cleared with swabs it may be necessary to make a further attempt after a purge or the patient may be given a bowel washout. The disadvantage of this procedure is that the mucosa may subsequently appear injected, blood or mucus in the lumen may no longer be visible and part of the liquid may remain in the rectum making visibility still worse. A long sucker which can be passed down the sigmoidoscope to clear the liquid is a most useful addition to the standard sigmoidoscope equipment.

The Strauss sigmoidoscope with distal lighting gives in an empty bowel an excellent view but the light easily becomes covered with loose faeces and proximal lighting sigmoidoscopes have in this respect a great advantage. The Yeomans, the Morgan and Officer and the Lloyd Davies instruments are excellent and are all obtainable in both the ½ and the ¾" diameter sizes (Fig. 60). For routine use in diagnosis the smaller instrument is invaluable. It causes less discomfort to the

patient, is easier to pass into the lower sigmoid and because it is easier to pass the surgeon will be much less inclined to omit this examination at the first consultation The view obtained is quite sufficient to diagnose or exclude a carcinoma in the upper rectum or recto sigmoid but it is not so easy to perform a biopsy through it as with the larger instrument

When seen through the lumen of an instrument the characteristic feature of a rectal carcinoma is its raised everted edge and irregularly ulcerated centre Digital examination may have produced bleeding or clot may be seen in the base If the growth is constricting only the lower edge may be visible with loose faeces escaping through the lumen and constantly obscuring the view With biopsy forceps a piece should be taken from the edge and if practical also from the ulcerated centre A proliferative growth may be nodular friable and bleed easily on instrumentation

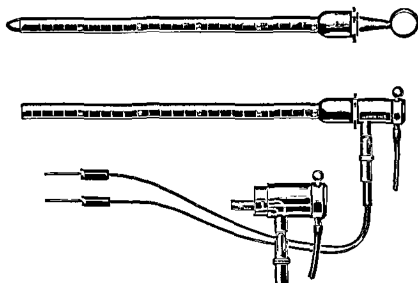


FIG 60

Lloyd Davies Sigmoidoscope

Proctoscopy and sigmoidoscopy should also seek to determine the condition of the surrounding rectal mucosa whether adenomata are present and if the instrument can be passed beyond the growth whether any other lesion can be seen If the carcinoma has infiltrated the bowel wall the feel of the hard growth against the sigmoidoscope or biopsy forceps is almost diagnostic A note should be made of the distance of the lower edge of the growth from the anal margin for this will influence the choice of operation

Barium Enema

This is seldom necessary for the diagnosis of a rectal carcinoma and may even lead to error unless a sigmoidoscopy is also performed The recto sigmoid is a difficult region in which to demonstrate a lesion and a negative radiological

finding may give assurance which is of little value, it does not exclude the possibility of a carcinoma On the other hand a barium enema is clearly indicated if sigmoidoscopy fails to reveal a suspected carcinoma if blood is seen in the lumen above the instrument or where the presence of a second carcinoma higher up is suspected by reason of clinical signs or the presence of multiple adenomata It is always indicated when a rectal growth is associated with conditions such as ulcerative colitis or familial polyposis

Difficulties in Diagnosis

The usual difficulties in the diagnosis of a rectal growth do not result from failure to recognize its appearance with the examining finger or sigmoidoscope but from failure to carry out a full and routine examination to exclude it The diagnosis of piles' and their treatment with some sort of ointment is a not uncommon mistake However there are a few conditions which may give rise to difficulty even after the most careful examination

Benign Tumours

Something has already been said regarding the diagnosis of malignant change in a benign tumour Biopsy, which is discussed more fully elsewhere, is the deciding factor but the pathologist can only report on the tissue submitted for examination and this may not be representative of the whole Where clinical signs are suspicious but biopsy is negative further biopsy must be performed, a negative result does not exclude carcinoma This difficulty can be very considerable when dealing with a large villous tumour of the rectum where a gritty feeling to the finger is a very suspicious sign Many hold the view that given sufficient time the majority of villous tumours become malignant but biopsy can only demonstrate the tissue selected by the surgeon and early malignant changes may be taking place elsewhere Continued observation, with local excision or diathermy destruction is the only line of treatment unless the surgeon feels that complete removal of the rectum is justified

Non-specific Ulcer of the Rectum

This is a rare condition with an unknown pathology but when it occurs it may give rise to great difficulty in diagnosis It presents as a solitary ulcer in the ampullary region usually on a valve edge with a tendency to stricture formation Clinically the ulcer does not have a raised everted edge and the base is usually smoother than a carcinoma not craggy not so hard and when viewed through an instrument may show red granulations after swabbing and an injected bleeding edge Biopsy shows chronic inflammatory granulation tissue and will naturally be repeated on several occasions while the patient remains under observation Rarely persistence of the ulcer stricture formation or bleeding may be an indication for radical surgery though in the great majority healing eventually takes place (Lloyd Davies 1959)

Amoebiasis

In certain countries amoebic dysentery is sufficiently common to be considered in the differential diagnosis when any patient presents with rectal symptoms It was unusual in Britain but a post war population and the increased frequency of travel has now made it a point in differential diagnosis

In amoebic dysentery more than one rectal ulcer may be present the surrounding rectal mucosa is almost always abnormal injected or oedematous and the ulcer itself may lie in the centre of a raised oedematous area Amoebae may be found on scraping the surface of the ulcer More difficulty arises in some of the chronic cases which may be associated with stricture formation but the characteristic edge and craggy base of carcinoma are never present Biopsy will show chronic inflammatory changes which are not specific

If an amoeboma is suspected but not proven it is justifiable to give a course of emetine for this will usually produce an obvious and rapid improvement Some hold that any large bowel carcinoma discovered in an area where amoebic dysentery is common should be given a course of anti dysenteric treatment because carcinoma may co exist with an amoebic infection and resection performed under these circumstances is believed to be attended with an increased risk

Lymphogranuloma Venereum

One of the manifestations of this disease restricted almost entirely to women is the development of a rectal stricture following a widespread inflammatory change in the pelvic lymphatics and connective tissues In the early stages there is oedema thickening and increased vascularity of the rectal wall and the area affected is more diffuse than a carcinoma Later there may be a dense stricture with fistulae These cases are now met with more frequently in London than they were in the past especially in districts where there are many immigrants Though the feel of the lesion is very different to that of a carcinoma they may be confused with an infiltrating type of growth Frei s Test is diagnostic of lymphogranuloma

Irradiation Proctitis and Ulcer

Following treatment for carcinoma of the cervix by radium or X rays changes may be produced in the rectal mucosa which may result in a severe stricture Fortunately this is rare but it is not so uncommon for a shallow ulcer or granulating area to be discovered on the anterior rectal wall and these may be very slow to heal They usually present with rectal discomfort and bleeding and may be suspected either as a rectal carcinoma or as an invasion from the original cervical growth

Endometriosis

This condition occasionally affects the rectum recto vaginal septum and recto sigmoid region and may be associated with ovarian endometriosis It may

be a small subserous nodule or a larger mass involving the bowel wall and the rectal symptoms usually have a relationship to menstruation If the area is within the reach of a digital examination the mucosa is usually found to be intact if ulcerated the diagnosis from carcinoma is much more difficult Sigmoidoscopy and biopsy are essential but the lesion may be beyond the instrument In the case reported by Korn and Savage (1957) attempts failed to negotiate the recto sigmoid region

A barium enema may show constriction of the bowel over a longer area than is usual with carcinoma and an intact mucosal pattern Diagnosis may not be possible until laparotomy and even then may still be in doubt (MacLeod 1946) Biopsy from the serous surface is advised by Colcock and Lamphier (1950)

Extension from Carcinoma of Prostate or Cervix

It is rare for a growth from these sites to present first with rectal symptoms though less so with the prostate than the cervix Perhaps initially regarded as an advanced rectal growth other signs indicating its origin are usually present and biopsy is almost invariably decisive

Syphilis

A primary chancre of the rectum or anal canal may occur in either sex and on occasions has been mistaken for a carcinoma and the patient treated by combined excision Diagnosis will rest on a dark ground test and Wassermann reaction Gummatous disease could affect the rectum and produce a stricture but it is probable that most of the cases regarded as syphilitic in the past were lymphogranuloma inguinale

Tuberculous Proctitis Sarcoidosis Crohn's Disease

Examples of these diseases presenting as an indurated area or ulcer may sometimes be found in the rectum, perhaps associated with a fistula and leading to stricture Other evidence of disease may be present elsewhere in the body and the pathological distinction between them may be a great deal more difficult than the differential diagnosis from carcinoma by biopsy

Injection Ulcer Oleogranuloma

Following the injection treatment of haemorrhoids a reaction develops in the submucous space and a raised indurated swelling can be felt on digital examination which tends to subside in the course of the next few weeks If some of the carbolic oil has been injected into the actual mucosa necrosis followed by a small ulcer is likely to take place and this with the underlying swelling might cause difficulty if the past history were not known Healing is usually rapid Occasionally the inflammatory response produced by the injection of non absorbable oil may persist possibly due to some allergic like reaction and develop slowly into a chronic inflammatory mass known as an oleo granuloma

The constant use of Vaseline as an anal lubricant over many years has also been said to produce this effect Since the mass may not appear for months or even years after the injections it may be confused with a neoplasm and in fact there are instances where resection has been mistakenly performed (Symmers 1955) Tenesmus and rectal discomfort are likely to be the presenting symptoms and the mucosa covering the tumour may be mobile fixed or scarred (Murray 1958) Biopsy shows chronic inflammatory tissue with foreign body giant cells and droplets of oil in spaces embedded in fibrous tissue

Chronic Fistulae

A chronic fistula associated with a submucous extension and much scarring may produce an area of induration suggestive of carcinoma and perhaps only operative exploration and biopsy will confirm the diagnosis Colloid carcinoma may rarely arise within fistulae in the ano rectal region and Dukes and Galvin (1956) described 8 of these cases without any evidence of a primary tumour in the rectum They believed that the carcinoma developed within ectopic tracks of congenital origin and their findings emphasize the importance of histological examination on the material removed when operating on fistulae particularly when they are multiple of long standing or show colloid discharge

Sarcoma

This is a rare rectal tumour and may be spindle celled leiomyosarcoma lympho sarcoma or reticulum celled It presents most frequently as a tumour in the rectal wall covered by intact mucosa but later and more especially after biopsy the mucosa becomes ulcerated Clinically it may seem to be an innocent tumour or it may be quite indistinguishable from a carcinoma The diagnosis must depend on biopsy and unfortunately the histology is sometimes indecisive

Carcinoid Tumour

This is a rare tumour in the rectum usually presenting as a small firm submucous nodule The syndrome caused by over secretion of 5 hydroxytrypta mine has not yet been reported in connection with carcinoid tumour of the rectum Correct diagnosis will depend on biopsy

Diverticulitis

It might seem more apposite to consider the differential diagnosis between diverticulitis and carcinoma as affecting the sigmoid colon rather than the rectum but in fact this problem arises with any lesion of the recto sigmoid which cannot be touched with the finger or reached with the sigmoidoscope A car cinoma of the recto sigmoid or sigmoid may be felt through the anterior rectal wall as a mass but it may not be possible to pass the sigmoidoscope round the corner to reach it Similarly diverticulitis may produce a thickened sigmoid or an adherent pelvic mass and the same finding on rectal examination Rarely diverticulitis may affect the upper rectum Since both diseases occur in the same

age group, in the same site and quite commonly co exist difficulties in diagnosis are to be expected

The case for diagnosis usually presents as an elderly patient with a history of bowel irregularity some lower abdominal pain and perhaps the passage of blood On rectal examination a mass can be felt in the Pouch of Douglas but the sigmoidoscope cannot fully cover the recto sigmoid region Differences in the clinical picture of these two diseases, each of little significance may together assist the diagnosis (Muir 1956)

The history is usually longer in diverticulitis perhaps with periods of remission Obesity seems to be associated with diverticulitis and a history of weight loss is present in at least 20 per cent of recto sigmoid carcinomas Pain and recurrent attacks of pyrexia favour a diagnosis of diverticulitis as does also a large tender mass in a fit patient in an ill patient it suggests carcinoma Bleeding is said to occur in 20 per cent of cases of diverticulitis but as a persistent complaint it is more common in carcinoma Massive haemorrhages are more common with diverticulitis than with carcinoma

Diagnosis is frequently made on the result of a barium enema It is probably true to say that in no other part of the alimentary tract with the possible exception of the oesophago gastric junction is the skill and experience of the observer more important and especially since in this age group both conditions may co exist The following are some of the characteristic features in the diagnosis

Carcinoma	*Diverticulitis*
Filling defect	Narrowed area
Sharp edges	Saw tooth spasm
	Tails off
Short distance	Several inches
Mucosal pattern destroyed	Mucosa intact
Appearances constant	Appearances vary
	Improves with antispasmodics
	Diverticula

A negative barium enema does not exclude a carcinoma though the error is probably less than 10 per cent Ramsay (1956) described 10 cases where this investigation failed to demonstrate a carcinoma subsequently found at operation In the presence of clinical signs a negative or doubtful barium enema must be repeated possibly after a course of antispasmodics and if there is still doubt laparotomy is required

Cytology

Bader and Papanicolaou (1952) reported 19 cases of cancer of the colon and rectum where a positive diagnosis of malignancy was made on 18 by cytological methods in the remaining case a benign polyp was diagnosed and later found to b malignant There is now sufficient evidence to show that cytology may be of som assistance in the diagnosis of doubtful bowel lesions but it is quite certain that the methods require experience and specialized skill both for technicians and pathologist and this particular experience is seldom available at present

For lesions which are beyond the reach of finger and sigmoidoscope examination under an anaesthetic may be of considerable value and is also useful in estimating operability When X rays and other methods have failed to establish a diagnosis laparotomy is essential though even here a fixed pelvic mass may be of uncertain aetiology Lloyd Davies (1953) has advocated the introduction of a sigmoidoscope during the laparotomy with the patient in the lithotomy Trendelenburg position and threading it through the affected area of bowel after the loop has been freed Resection should always be performed in a doubtful case

Carcinoma of the Anus

A squamous celled carcinoma may occur in the skin around the anal orifice or in the lower part of the anal canal Gabriel (1948) found that carcinoma of the anus was more common in males than females and more often of low grade malignancy while that of the anal canal was more common in females and usually of higher malignancy The growth may appear as a papilloma with or without ulceration and induration at its base as an ulcer with hard edges or as an indurated area in the base of a fissure The surrounding skin may be normal or may show the changes of old standing pruritus occasionally of irradiation for pruritus and especially in elderly women of leucoplakia or hyper keratosis involving also the vulval region The inguinal glands may be involved

Clinically the diagnosis will usually be made on the appearance of the ulcer its hard edges and its induration Other conditions which may cause difficulty in diagnosis are a simple papilloma the chronic ulcer of a fissure a tuberculous ulcer a primary chancre a fissured area in leucoplakia a rodent ulcer and the downward spread of a columnar celled carcinoma of the rectum Where any doubt exists biopsy or the complete excision of the suspicious area should be performed

Conclusion

It may seem from this discussion that the diagnosis of rectal cancer is frequently difficult but this is not the impression I seek to convey In the great majority of cases the diagnosis is easily made always provided no method of examination is omitted and undue reliance is not placed on a negative digital examination of the rectum The characteristic story is bowel irregularity and bleeding the characteristic feel a hard everted edge and the common fault the acceptance of a negative finding without complete investigation

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CHAPTER XII

BIOPSY DIAGNOSIS OF RECTAL CANCER

WILLIAM B GABRIEL

BIOPSY of the rectum is an established procedure of great value for the confirmation of a clinical diagnosis of malignancy and usually enables a correct pre operative diagnosis to be made between adenocarcinoma squamous celled carcinoma and sarcoma In lesions of doubtful aetiology biopsy is of supreme importance and often reveals without delay the exact nature of obscure granulomatous lesions such as amoeboma oleoma and tuberculous rectal lesions examples of which are illustrated in Figures 65 66 and 67 Biopsy is also useful when lesions appear clinically to be definitely malignant partly for the purpose of confirming the clinical diagnosis and partly for providing an estimate of the grade of malignancy Examples of adenocarcinoma of a low and high grade of malignancy are illustrated in Figures 68 and 69

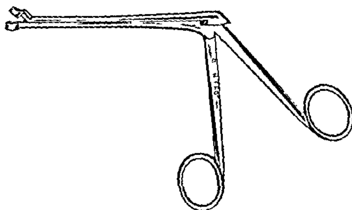


FIG 61

Hartmann s conchotome (the small medium size is recommended—from Messrs Down Bros and Mayer & Phelps)

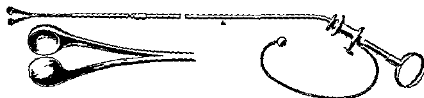


FIG 62

Brunings forceps The inset shows the hollowed cutting ends 8 mm in diameter in natural size

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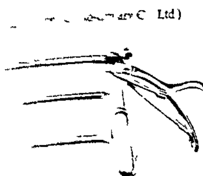
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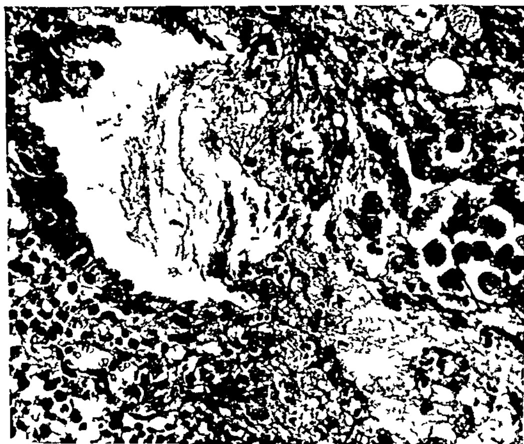


FIG 65

High power view of amoebic ulcer of rectum showing colony of E histolytica in the mucosa (× 450)

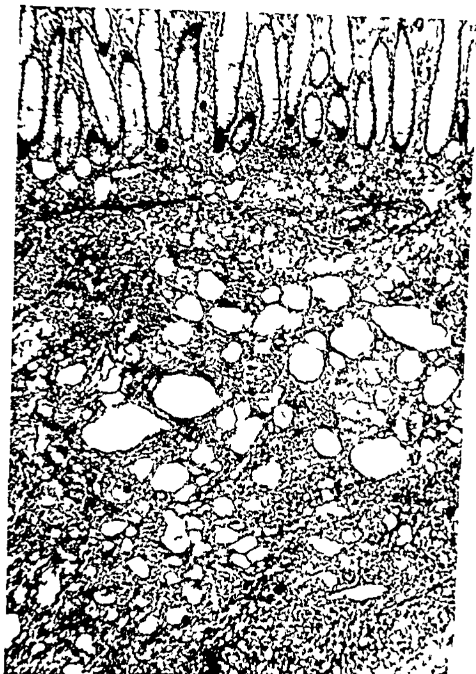


Fig 66

Oleoma of rectum The submucosa contains numerous cystic spaces occupied by non absorbable oil and surrounded by dense fibrous tissue (× 30)



FIG 67

Fragment from ulcer of lower rectum and upper anal canal the histological app arances of which were suggestive of tuberculosis and in which numerous tubercle bacilli were demonstrated (× 150)



FIG 68

Adenocarcinoma of rectum Low grade of malignancy (× 100)



Fig 69
Adenocarcinoma of rectum High grade of malignancy (× 100)

tuberant type pieces should be taken from several different sites (Fig 70) In the case of a villous tumour if clinical examination reveals any particular areas of induration or friability these should be specially selected for biopsy, the examination may need to be repeated if malignant change is strongly suspected but not confirmed at the first biopsy

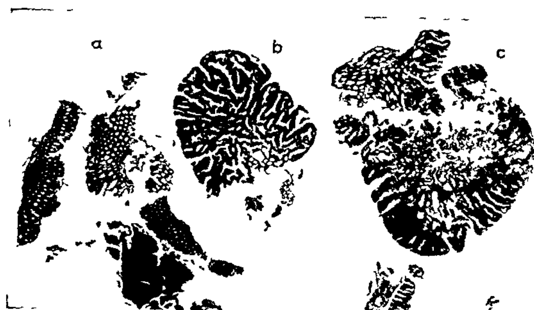


Fig 70

Group of biopsy fragments removed from a rectal growth showing (a) normal mucosa (b) adenoma and (c) area of adenocarcinoma (× 10½)

Complications

Haemorrhage

Occasionally brisk bleeding occurs after removal of biopsy fragments from a vascular rectal neoplasm and this seems specially liable to happen when we are dealing with a sarcoma

Treatment

Firm pressure with relays of dry cotton wool swabs held in the punch forceps or long alligator forceps usually suffices to control the bleeding Pledgets of wool moistened in 1 in 1 000 adrenalin may be applied in rotation with the dry cotton wool swabs If this does not suffice to stop the bleeding the patient should be admitted for observation, with the foot of the bed raised on blocks there is not likely to be any further trouble A rubber tube with a lumen of 1 cm should be passed through the anal canal in order to prevent a concealed haemorrhage from developing If bleeding follows the removal of a fragment for biopsy from a lesion in the anal canal it can readily be controlled by plugging the rectum with a tube and surround as for a secondary haemorrhage after haemorrhoidectomy

Perforation

This is of course a possible accident which must be extremely rare it should be avoided if care is taken to remove biopsy fragments from the margin of an ulcer rather than from the base where the rectal wall may be considerably thinned or even be on the point of a spontaneous perforation The height of the lesion above the anus should always be carefully considered and if it is clearly above the level of the peritoneal pouch additional care should be taken

We sometimes see cases of radium necrosis of the rectum following X ray or radium treatment to the cervix uteri and the question may be raised whether an ulcer in the anterior rectal wall is a radium ulcer or a malignant extension In such cases it may be unwise to attempt a biopsy in case a recto vaginal fistula is precipitated

Dissemination

Pieces have been removed for biopsy from malignant tumours at St Mark s Hospital for about 30 years and we have no direct evidence that dissemination of cancer has been caused or stimulated Indeed it is unlikely that taking a few fragments from the surface of a protuberant growth or the margin of a malignant ulcer would set free cancer cells into the bloodstream Every now and then however, the surgeon explores an early case and finds definite evidence of secondary deposits in the liver yet if a palliative excision of the rectum is done the growth may prove to be an A case with the growth limited to the rectal wall Whether in such a case the removal of a piece for biopsy could have played an active part in the dissemination is unlikely but debatable

Considerable restraint should in my opinion be exercised if ever a dusky tumour is met with in the anal canal or presenting at the anus and if there seems to be the least chance of this being a *malignant melanoma* it is surely wise to defer biopsy until the patient has been admitted to hospital and prepared for a major operation By the frozen section technique in the theatre an accurate diagnosis should be possible and if the presence of a melanoma is confirmed an immediate abdomino perineal excision will give the patient the only chance of cure, slim though it may be

Biopsy of Anal Ulcers

This is a matter deserving the most careful thought and is greatly aided by long clinical experience The following points may be found useful in deciding whether a biopsy is indicated or not

1 If digital examination reveals a malignant ulcer of the rectum or anal canal extending to the anus there is no objection to doing a biopsy which will demonstrate the histological type whether adeno or squamous celled carcinoma
2 If the lesion is a typical squamous celled carcinoma of the anus localized and capable of being excised by a local procedure then there is no great

object in doing a biopsy and it would be better to excise the growth widely with cutting diathermy and send it for section

3 If there is any question of radiotherapy being used in treatment then of course a biopsy is essential

4 In the case of an anomalous ulcer the possibility of an anal chancre should never be overlooked, a Wassermann reaction and dark ground search for spirochaetes will quickly clear up this diagnosis

5 If the ulcer appears to be superficial or undermined it may well prove to be tuberculous and before cutting into it to obtain a piece for biopsy an X ray of the chest and sputum examination may clearly settle the diagnosis by revealing active pulmonary tuberculosis

Conclusions

Rectal biopsy can be correct in over 95 per cent of cases (Gabriel Dukes and Bussey 1951) It may be difficult for the histologist to say if an undifferentiated high grade carcinoma should be considered to be a columnar-celled or squamous celled lesion but in actual practice this makes little difference to the surgical treatment One of the most difficult problems occurs with villous tumours which may be benign on the surface and malignant at the base in such cases the clinical estimate is probably of more importance than the biopsy findings

Another difficult problem is to differentiate an *endometrioma* from a low grade carcinoma by biopsy (Tagart 1959) When there is any doubt the clinical findings may be a great help to the pathologist if the patient is a female under 50 years of age and the growth is situated anteriorly in the recto sigmoid region or in the recto vaginal septum the pathologist will get an important lead towards a correct diagnosis

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SECTION FIVE

THE TREATMENT OF RECTAL CANCER

CHAPTER XIII

CHOICE OF OPERATION IN THE TREATMENT OF CARCINOMA OF THE RECTUM AND RECTO-SIGMOID

J C GOLIGHER

ONLY two forms of treatment are capable of offering any prospects of cure of carcinoma of the rectum at the present time namely surgery and radio therapy Although advances in radiotherapy in recent years have undoubtedly *increased its value surgical excision still remains* our principal mode of treat ment for rectal cancer Many different techniques have been devised for re moval of the rectum for malignant disease the more important of these will now be briefly surveyed

EVOLUTION OF SURGICAL EXCISION OF THE RECTUM

Perineal Excision

The first attempt to excise the rectum by this route was made by Faget in 1739 and again by Lisfranc in 1826 The use of this operation then lapsed for nearly half a century till Verneuil revived it in *1873* To improve access he sug gested prolonging the anal circumcision backwards and removing the coccyx The levator muscles were then severed close to the rectum and the bowel divided an inch above the uppermost border of the growth but below the peritoneum This entirely extra peritoneal type of operation was also the method practised in this country till after 1900 by H W Allingham (*1901*) the rectum being split posteriorly to facilitate the dissection which was kept very close to the rectal wall No attempt was made to bring the cut edge of the bowel down to the skin margin but instead the wound was left to granulate However to diminish the severity of the resulting perineal sepsis he favoured the establishment of a pre liminary inguinal colostomy Clearly this operation was only practicable for growths of the anal canal and lower end of the rectum

The credit for developing this inadequate method into a worthwhile cancer operation belongs to J P Lockhart Mummery (1907 1920) Like Allingham he also employed a preliminary loop iliac colostomy taking the opportunity to *perform an exploratory laparotomy to assess the operability of the* growth and to determine the presence of hepatic or peritoneal deposits The perineal opera tion was performed about two weeks later during the interval the distal bowel was washed out daily though the colostomy At operation the patient was placed on the left side with the knees drawn up and a wide elliptical incision *made round the anus and prolonged backwards to the coccyx* which was excised The levatores ani were divided some distance from their attachment to

the bowel and the plane of cleavage between the front of the rectum and the prostate and vesicles followed by careful dissection till the pelvic peritoneum was encountered This was opened and the cut prolonged upwards with scissors on either side of the rectum The lateral ligaments were then divided complet ing the mobilization The rectum could now be drawn down strongly whilst the superior haemorrhoidal vessels were isolated posteriorly and ligated as high as possible Lastly the bowel itself was severed between crushing clamps in the upper part of the wound and the blind stump closed The wound was sutured loosely around a large rubber drain

By this extended perineal excision it was possible to remove on the average about 9 or 10 inches of rectum and distal colon and Lockhart Mummery (1926) used it for practically all rectal cancers but admitted that it was unsuitable for lesions of the upper rectum or recto sigmoid The operation was a restricted one even for carcinoma of the rectum proper, for as Gabriel (1948) has pointed out, the highest possible point of ligation of the superior haemorrhoidal vessels through a purely perineal wound is 2 to 3 inches below the promontory of the sacrum (which is 4½ to 5½ inches below the bifurcation of an abdominal aorta and 6 to 7 inches below the origin of the inferior mesenteric artery) Another disadvantage is the mechanically unsatisfactory arrangement of a blind end of bowel distal to the colostomy which may leak and give rise to a mucous fistula or even to a discharge of faeces through the perineal wound But Lockhart Mummery (1926) was able to show that the method could be very satisfactory in actual practice despite these objections This was amply confirmed by the col lective experience of the staff of St Mark s Hospital where up to the early 1930 s this technique of preliminary laparotomy and colostomy followed by extended perineal excision was routine for most excisable cancers of the rectum From 1910–31, during which time the operability rate for rectal cancer was 50 per cent, 370 patients were treated by perineal excision with an immediate mortality of 11 6 per cent and a 5 year survival rate of 40 per cent (Gabriel 1932)

The chief virtue of this operation was that in the days before blood trans fusion and other ancillaries of modern surgery it was a relatively safe and simple operation for the general surgeon For this reason it became popular in this country and America where it was known either as Lockhart Mummery s operation or as posterior excision The main inadequacy of the perineal opera tion is in dealing with upward lymphatic spread, as shown by Gabriel (1948) in a comparative study of the late results of perineal and combined abdomino perineal excision (see Table XIV) There was no significant difference in the 5 year survival rates for the two operations in cases without lymphatic metastases (A and B cases) but when lymphatic spread had occurred (C cases) perineal excision was notably less efficient than the combined operation In recent years with the increasing safety of surgery most surgeons have preferred more radical methods than perineal excision but it certainly played a valuable role in the management of rectal cancer during the years between the first and second world wars

TABLE XIV

Five Year Survival Rate after Excision of the Rectum

(St Mark s Hospital Statistics—Dukes)

(Operation deaths excluded)

Gabriel 1948

Group	*Perineal Excision (per cent)*	*Combined Excision (per cent)*
A	82 2	83 9
B	61 7	62 3
C	17 9	31 0
Total	44 9	47 1

Sacral Excision

Though this method had been employed by Kocher in 1875 its introduction into surgical practice was due to Kraske who described the technique in detail to the 14th Congress of the German Association of Surgeons in 1885 and it has been associated with his name ever since With the patient lying on the left or right side an incision was made from behind the anus over the lower sacrum usually inclining to one or other side of the midline Removal of the coccyx and the lowermost two pieces of the sacrum gave good access to the back of the rectum above the levator muscles The peritoneum was opened on one side of the bowel which was then drawn downwards as far as possible and the superior haemorrhoidal vessels divided Inferiorly the dissection was carried as far as desired the operation being completed either by excising the entire rectum and anal canal and establishing a sacral anus at the posterior end of the wound—so called *amputation of the rectum*—or by removing a sleeve of bowel containing the growth and restoring continuity by end to end anastomosis—so called *resection of the rectum*

Sacral excision rapidly became the most popular method in Germany and Austria and various modifications of Kraske s original technique were introduced by Bardenheuer Rose Hochenegg Billroth Rehn Heinecke and Rydygier (see Rankin Bargen and Buie 1932) Other innovations related to the method of restoring continuity if a resection were performed for it had become apparent that end to end anastomosis by simple circular suture was prone to be followed by break down and the formation of an intractable fistula In an endeavour to avoid this complication Hochenegg (1888 1889) developed two alternative techniques for effecting union (*a*) The *invagination method* in which the upper edge of the distal stump of bowel was turned into the lumen and out through the anus whilst the proximal stump was drawn down through it so

that the cut edges of the two tubes of bowel could be united by suture outside the anus and (*b*) The '*durch Zug method*, in which the distal stump was turned inside out through the anus and stripped of its mucosa, it then being returned to the pelvis and the proximal stump drawn down through it to the anal orifice where its cut lower edge was sutured to the skin It was hoped thereby to effect a broad union between the serous surface of the colon and the raw inner aspect of the lower rectum and anal canal but it is not at all clear that this was often achieved in practice (see Mandl 1922) Kuttner (1910 1916) recognizing the inevitability of frequent dehiscence of the bowel suture line if primary anastomosis were attempted developed a technique of extraperitoneal resection through the sacral wound with subsequent staged closure akin to that of the Paul Mikulicz type of colectomy A proximal colostomy was not often employed by Continental surgeons in conjunction with sacral resection as a temporary defunctioning manoeuvre

A good exposition of the results of these sacral operations was provided by Mandl (1922, 1929) who conducted a statistical analysis of the clinical material at Hochenegg s Clinic in Vienna In his second report he referred to a total of 1 704 patients with rectal cancer of whom 984 were subjected to sacral excision with an immediate mortality of 11 6 per cent The 5 year survival rate was 30 per cent Approximately half the operations were conducted as *amputations* with establishment of a sacral colostomy, and half as *resections* with restoration of continuity In an endeavour to increase the upward scope of sacral excision Westhues (1933) recommended the use of the prone or hanging belly position for this operation This certainly improved access to the upper pelvis, and by employing this method and adopting an extra fascial pre sacral approach to the vascular pedicle Goetze (1931) claimed that he could tie the inferior mesenteric vessels almost at the promontory of the sacrum Even this fell short of what could be achieved by operations including an abdominal phase so that as these became safer, they gradually displaced sacral excisions on the Continent

The sacral operation never enjoyed much vogue in this country or America despite its strong advocacy by Harrison Cripps (1907) Swinford Edwards (1908) and Grey Turner (1931)

Combined Abdomino perineal or Perineo-abdominal Excision

A combined operation involving abdominal and perineal phases for excision of the rectum was first performed by Czerny (1883) not as a premeditated plan but as a means of finishing a sacral excision which he had found himself unable to complete from below In carrying out combined excision as a deliberate procedure most surgeons have preferred to perform the abdominal phase first It is difficult to discover who originated this method but it was early associated on the Continent with the name of Quenu However it was undoubtedly the work of Ernest Miles (1910) that established the abdomino perineal operation in favour in England and America As a result of his researches into the mode of spread of rectal cancer he concluded that a radical excision for this condition

wherever situated in the rectum ought to embrace the following structures the entire rectum including the anal canal and sphincters as much as possible of the levator ani muscles and ischio rectal fat, practically all the sigmoid colon and mesocolon including the superior haemorrhoidal and inferior mesenteric vessels and glands lying in its base, and a portion of the pelvic peritoneum adjacent to the rectum Obviously nothing short of an extensive abdomino perineal operation and permanent colostomy would satisfy these criteria and his consistent advocacy of this form of operation and his masterly technique in executing it resulted in the abdomino perineal excision being known through out the world as the Miles operation

The great drawback to this operation when first introduced was that it was associated with severe shock and had a high initial mortality Thus in the first 61 cases treated by Miles during the period up to 1914 there were 22 immediate deaths a mortality of 36 2 per cent As a consequence abdomino perineal excision was only very slowly adopted by surgeons in general but the advances of the last two decades have made it possible to carry out combined excision with a steadily decreasing mortality It has now become the most commonly accepted operation for rectal cancer in Britain and America

The technique of the Miles operation will be described in detail later (see p 169) but certain modifications introduced with the object of simplifying its performance or making it safer will now be mentioned

Two Stage Combined Excision

Some surgeons thought that if the operation were divided into two stages it might be better borne by the patient The first stage consisted either of the establishment of a colostomy alone or combined with a variable amount of abdominal dissection of the rectum and division of its superior vascular pedicle Such techniques were described by Coffey (1915) Fiske Jones and McKittrick (1922) Rankin (1929) and Lahey (1930) all of which were at one time believed to be valuable but these methods of performing two stage combined excision have now been abandoned in favour of a one stage operation

Perineo abdominal Excision

The original technique of Czerny (1883) was allowed to lapse till Grey Turner revived it as a two stage operation in 1920 Gabriel (1934) subsequently developed this method as a single stage procedure and has been its chief advo cate He considered that it is less liable to cause shock than abdomino perineal excision and for a surgeon familiar with perineal dissections much simpler to perform than the Miles operation In fact it is really a perineal excision finished through the abdomen to give a higher division of the main vessels a greater removal of bowel and a terminal colostomy rather than a loop colostomy with a distal blind end The detailed technique is described on p 177

Gabriel s (1957) unique experience has demonstrated beyond question that this method is a safe one But to the average surgeon who has not had the benefit of the long apprenticeship in perineal excision that Gabriel enjoyed with Lock-hart Mummery the abdomino perineal method in which the bulk of the dis

section is done from above, seems to make better use of his general abdominal experience than does the perineo abdominal operation This may be the reason why this operation has never become as popular as its merits would seem to warrant

Synchronous Combined Excision

Bloodgood (1906) and Clogg (1923) both suggested that with a suitable arrangement of the patient, the abdominal and perineal phases of a combined excision might be performed simultaneously and both of them essayed such operations but it was Kirschner of Heidelberg (1934) who demonstrated conclusively that this was a practicable procedure Devine (1937) introduced the method afresh to the English speaking world, and Lloyd Davies (1939) by devising special adjustable leg rests to support the patient in the lithotomy Trendelenburg position necessary for a synchronous approach to abdomen and perineum greatly assisted the development of the operation The advantages claimed for this method are that it saves much operating time, makes the removal of fixed growths easier because dissection can proceed from above and below simultaneously, and facilitates suture of the pelvic peritoneum

Certain criticisms have been levelled at the synchronous technique First of all it is said that the lithotomy Trendelenburg position offers a less satisfactory approach for both the abdominal and the perineal dissections but with attention to the details of the initial positioning of the patient and the arrangement of instrument tables and towelling etc satisfactory access can nearly always be obtained for both operators Secondly, the synchronous operation is said to be more liable to cause shock than an ordinary abdomino perineal or perineo abdominal excision because the total trauma is inflicted in a shorter space of time from two fields simultaneously but I doubt if there is any evidence for this belief And thirdly two surgeons are required for this operation instead of one This may prove inconvenient and I would emphasize that it is not sufficient to assign the perineal part of the excision to a junior assistant because the anterior dissection from below is often the most difficult part of the whole operation Even if an experienced colleague is available it must be admitted that some surgeons are by temperament disinclined to delegate responsibility for such an important share of the operation to an associate It is of course possible for a lone operator to use the lithotomy Trendelenburg position to perform an abdomino perineal or perineo abdominal excision in sequence rather than synchronously though this means losing some of the advantage of the position

These questions may be disputed but in fact this method has now become the favourite technique for combined excision of the rectum throughout the British Commonwealth In America it often goes by the name of the two team technique but has enjoyed only slight popularity The same is true in Germany and other Continental countries

Extended Combined Excision

In recent years attempts have been made to increase the scope of combined excisions still farther in various ways

1 *Higher ligation of the inferior mesenteric vessels with or without extended left colectomy* Miles (1926) recommended that in the performance of his operation the main ligature should be placed opposite the bifurcation of the abdominal aorta This tie usually lies just below the origin of the left colic or first sigmoid artery so that whilst it permitted a fairly high division of the inferior mesenteric vessels it also ensured a good direct blood supply to the portions of the colon selected for the establishment of the colostomy However the inferior mesenteric artery arises from the aorta 1½ inches above this point and the Miles technique therefore leaves a small portion of vessel with related lymph glands Recently Deddish (1950) State (1951) Ault Castro and Smith (1952) and Grinnell and Hiatt (1952) have recommended tying the inferior mesenteric artery at its origin from the abdominal aorta in order to avoid leaving this remnant of artery and associated lymphatics Moynihan (1908) actually made a similar suggestion many years earlier, but it attracted little attention From the pathological point of view such a ligation on the aorta would seem to be an eminently logical extension of radical excision for rectal carcinoma and Grinnell and Hiatt (1952) and McElwain Bacon and Trimpi (1954) refer to specimens showing neoplastic lymph glands at the upper end of the inferior mesenteric chain which were removed by high ligation but would undoubtedly have been left *in situ* if the vessels had been divided at the level of the aortic bifurcation It must be admitted however that in cases with lymphatic metastases of this extent the prognosis is probably very poor anyway and may not be much influenced by this increase in the scope of operation even if extended to include dissection of glands off the front of the abdominal aorta as suggested by Grinnell and Hiatt (1952) The precise value of higher ligation of the inferior mesenteric vessels remains to be established by a long term follow up of comparable series of cases with and without this additional extension but there is certainly a good theoretical basis for its trial

An obvious consequence of ligation of the inferior mesenteric artery at its origin is that the left colic branch is sacrificed which means that the only blood supply remaining to the descending and iliac colon is that derived from the middle colic artery and conveyed by the marginal artery Some surgeons practising high ligation during rectal excision have taken the view that this supply would be adequate only for the survival of a limited amount of colon and have therefore recommended extending the resection almost up to the splenic flexure or into the transverse colon in order to diminish the amount of bowel nourished solely by the marginal vessels But observations by myself (Goligher 1954) and by Griffiths (1956) and Morgan (1956) show that these fears are without foundation and that in the majority of cases this marginal supply from the middle colic artery is adequate to maintain the viability of the left colon down to an iliac colostomy From the patient s point of view colostomy in this site has advantages over the less easily regulated more frequently acting transverse colostomy

An additional argument for resecting the left colon in conjunction with high ligation of the inferior mesenteric vessels is that the para colic glands alongside the iliac and descending colon may contain metastases and that their

removal by extended colectomy may make the operation more radical (State 1951) However, most researches into the spread of rectal cancer in recent years have shown that upward lymphatic extension is confined *with remarkable constancy* to the glands intimately related to the main superior *haemorrhoidal* and inferior mesenteric vessels Only in advanced, probably incurable cases in which these main glands have undergone extensive blockage by metastases would the paracolic glands be likely to contain growth, and their removal would probably make little difference to the ultimate *prognosis*

A further reason for resecting the left colon after high inferior mesenteric ligation is the possibly increased malignant potential of the mucosa of the entire large intestine, particularly in its distal half, in cases of carcinoma Excision of the left colon in addition to the rectum might thus be regarded as a sound prophylactic measure against the development of further primary growths, and might actually result in the removal of a greater number of associated polypi than would an ordinary rectal excision The precise value of this more extensive removal of large bowel still remains to be decided

2 *Excision of lymph glands from the pelvic sidewalls* Deddish (1950) and Sauer and Bacon (1952) have attempted to broaden the scope of radical excisions for cancer of the rectum by dissection of the internal iliac lymph glands These glands lie external to the parietal pelvic fascia and are quite untouched by an orthodox abdomino perineal excision even when the lateral ligaments are divided close to the pelvic side wall For their proper demonstration and removal the parietal pelvic fascia must be divided at the pelvic brim and dissected downwards exposing the glands as they lie on the iliac vessels and obturator muscle In 11 cases with intraperitoneal growths Sauer and Bacon (1952) found that the excised internal iliac glands were all free from deposits, but in 21 cases with extraperitoneal growths they noted metastases in the internal iliac glands in 6 They advised that pelvic adenectomy should be reserved for low lying growths My own experience is that when glands on the pelvic side wall are implicated the condition is really incurable for dissection of these glands can never be complete, it is moreover liable to be attended by considerable haemorrhage and operative difficulty which prolongs the operation thus increasing the immediate mortality and morbidity Deddish (1952) has commented on the increased incidence of post operative bladder complications after pelvic adenectomy A recent report on the late results of this manoeuvre by Stearns and Deddish (1959) show that it has not enhanced the curative value of the operation over that of ordinary combined excision

3 *Multi visceral resections and complete pelvic clearance* Not infrequently by the time the patient comes to hospital carcinoma of the rectum has become adherent to other organs anteriorly and if removal of the growth is to be accomplished these adherent viscera must be excised in part or *in toto* Removal of a loop of small intestine is a very simple addition to a combined excision of the rectum as is excision of the posterior vaginal wall which is sometimes advisable Ablation of an adherent uterus and uterine appendages by a Wertheim s hysterectomy is a more serious extension of rectal excision but when required can now be performed without inordinate risk Adherence to the pro

state seminal vesicles or bladder in the male patient is a more difficult problem It may sometimes be dealt with by removal of a thin shaving of tissue from the posterior aspect of the prostate and by excision of the vesicles and possibly an area of the bladder wall

Alternatively the drastic step may be taken of performing a total cysto prostatetectomy *en bloc* with the rectal excision thus effecting a complete pelvic clearance as has been urged particularly by Deddish (1950) and Appleby (1950) If this is done the surgeon is faced with the problem of how to dispose of the ureters In the past they were implanted into the sigmoid colon or the caecum But with these operations there is a danger of absorption of chloride from urine in the colon leading to hyperchloraemic acidosis and also a grave risk of ascend ing urinary infection as emphasized by Jacobs (1949) To avoid these disadvan tages of uretero colic implantation Bricker (1950) has advised that the ureters should be implanted into an isolated short segment of lower ileum the distal end of which is brought to the surface as a urinary ileostomy This piece of ileum acts not as a substitute bladder but as a short conduit to the surface conveying the urine immediately into an ileostomy bag For that reason it is superior to the construction of a substitute urinary bladder from the caecum as suggested by Gilchrist Merrick Hamlin and Rieger (1950) because this arrangement provides opportunities for considerable re absorption of urinary electrolytes in the intervals between emptying of the bladder

Diversion of urine into an ileal loop has been extensively practised by uro logical surgeons in connection with total cystectomy for carcinoma of the bladder Pyrah and Raper (1955) give a good account of the technique and results of this manoeuvre A sutured uretero enteric anastomosis as advised by Cordonnier (1950) and Nesbit (1948) to secure apposition of the ureteric and ileal mucosa is recommended instead of the simpler pull through method of Coffey (1931) which usually leads to stenosis and hydronephrosis It should be borne in mind that the operative steps required to construct this form of urinary ileostomy may represent a critical addition to the already formidable procedure of complete pelvic clearance The tendency to acidosis after conventional uretero sigmoid anastomoses can be combated to some extent by prescribing large doses of sodium bicarbonate by mouth as recommended by Ferris and Odel (1950) However the patient is still exposed to the risk of ascending urinary infection which will probably lead eventually to considerable impairment of urinary function

An alternative to any form of uretero intestinal anastomosis after pelvic clearance is to bring the ureters to the surface as cutaneous ureterostomies but these are usually more difficult to fit with a satisfactory appliance than is an ileostomy or wet colostomy Fish and Stevenson (1949) however have des cribed what they term a pedical graft cutaneous ureterostomy of an abdominal flap of skin and subcutaneous tissue The fitting of a ureterostomy cup is thus said to be facilitated

Sphincter saving Resections

Following the work of Westhues (1930 1933) Dukes (1930 1940) and other

investigators which showed that the lymphatic spread of rectal cancer is mainly in an upward direction there has been a great revival of interest in Britain and America of the possibility of sphincter preservation in the radical excision of carcinoma of the upper rectum and recto-sigmoid and various forms of sphincter saving resection have been revived or developed

Sacral Resection

Though many hundreds of resections with restoration of continuity by the sacral route have been performed in Continental clinics since the latter end of the last century, as explained on p 190, this method suffered two disadvantages first there was the considerable tendency of the anastomosis to break down and give rise to an intractable sacral fistula as mentioned on p 190, and secondly, by modern standards it could only be regarded as an inadequate operation so far as removal of the tissues in the upward zone of lymphatic spread was concerned In the recent revival of sphincter saving resections therefore it was natural to turn rather to methods incorporating an abdominal phase which permitted of high ligation of the inferior mesenteric vessels as in an orthodox combined abdomino perineal excision

Abdomino Sacral Resection

This operation which was first suggested by Kraske, has been extensively practised in recent years by Finsterer (1941), Goetze (1944) and above all d Allaines (1956) It was also the first method employed by Pannett (1935) one of the earliest pioneers of sphincter saving resection in this country In this technique the main vessels were tied and the sigmoid colon and rectum mobilized as in the abdominal phase of Miles s operation but the bowel was not divided Instead it was pushed down into the pelvis and the pelvic peritoneum sutured over and around it The abdomen was then closed and the patient placed on one side in a prone position, or in an exaggerated lithotomy position and a sacral incision made through which the appropriate amount of bowel was resected and union effected by end-to end anastomosis

Unfortunately the risk of formation of a persistent faecal fistula through the posterior wound still remained in sacral resection, as Goetze (1944) and d Allaines (1956) clearly recognized In addition the patient was exposed to all the ordinary discomforts of a perineal or sacral wound which certain other techniques avoid It has never been a popular method in this country or America and Pannett (1951) eventually gave it up in favour of a purely abdominal resection

Abdomino-Anal Resection

The pull through operation This technique as practised by Sebrechts (1935) Rayner (1935) Babcock (1939 1947) Bacon (1945) and Black (1952) is probably the most popular type of abdomino anal resection In it the rectum and sigmoid are mobilized from the abdominal aspect down to a level just above the anal sphincters In the Bacon (1945) version, which is the one most com

monly practised continuity is then restored by a method similar to the *durch Zug* technique of Hochenegg (see p 150) in other words the mucosa of the ano rectal stump is cored out—the internal sphincter often being damaged in the process—and the colon is drawn down through the bared anal canal Most of the bowel is amputated leaving a 2 inch stump into which a stout tube is tied When union has taken place between the outer aspect of the colon and the inner raw surface of the canal the excess of colon projecting from the anus is removed by diathermy

A cogent criticism of this operation is that though it preserves the sphincters —or at any rate the important external one—it sacrifices the sensitive anal and lower rectal mucosa which is probably as important in the mechanism of con tinence as is the musculature itself and as a consequence the patients are often incontinent Bacon (1945) and Waugh *et al* (1954) who have used this operation extensively admit that most of the patients are not properly continent after it, but claim that about a third of them have something akin to normal function My experience of 8 patients on whom I performed the Bacon operation taking special care to preserve both anal sphincters in an undamaged condition was that they were all incontinent and had nothing better than anal colostomies Four of them were subsequently converted to abdominal colostomies with more satis factory results

In Babcock s (1939) and Black's (1952) versions of this operation the anal mucosa is not excised and the outer surface of the colon stump drawn through the anal canal rests in contact with the intact anal lining so that union can only take place between the cut upper edge of the anal canal and the colon There apparently is a real risk that this junction may be inadequate to prevent the colon stump from pulling up into the pelvis particularly if the part in and beyond the anal canal is subjected to the strangulating effect of the tonic sphincter contraction For this reason Babcock advises that the sphincter muscles should be divided in the midline posteriorly and resutured round the indwelling colon a proceeding that would certainly not seem to augur well for subsequent continence At a later stage when sound union has taken place the colon projecting beyond the site of healing with the upper end of the anal canal is excised with diathermy

The Maunsell Weir Operation This method of abdomino anal resection was suggested by Maunsell (1892) and first practised by Weir (1901) A similar tech nique was elaborated quite independently by Lloyd Davies (1950)

After an entirely abdominal dissection the rectum is resected leaving a long stump and a short ano rectal one The anastomosis is then completed in a man ner very similar to Hochenegg s (1889) invagination technique for union after sacral resection the ano rectal stump being turned inside out through the anus so that its cut upper edge becomes the projecting lower margin and the colon stump is drawn down through it so that the free edges of both stumps lie oppo site one another and can be sutured together outside the anus The anastomosis is then pushed back through the anus into the pelvis This method enables one to achieve a very low colo rectal anastomosis without a sacral or perineal wound and without sacrificing the mucosa of the anal canal or rectum, or

damaging the anal sphincters The functional results are much better than after the Bacon Babcock operation, and the majority of patients eventually attain normal continence after it (Goligher 1951) However many of them pass through a rather uncomfortable phase at first when they are troubled by frequent small motions, and their control for flatus and liquid faeces may be somewhat impaired It is in fact usually 4 to 6 months before rectal function becomes really dependable It must be admitted also that complications referable to breakdown of the anastomosis are common after this operation and a proximal transverse colostomy should always be established at the time of the resection This method in recent years has been almost completely supplanted by anterior resection

Abdominal or Anterior Resection

(*a*) *Without anastomosis* At a time when anastomosis of the colon to the rectum after abdominal resection of carcinomata of the upper rectum or recto sigmoid was particularly difficult and dangerous, Hartmann (1923) finished such a resection by closing the upper end of the rectal stump and establishing a terminal iliac colostomy This carried some risk of a leak from the suture line on the top of the rectal stump, but this was less than that from an actual anastomosis Rankin (1939), Muir (1939) and Gabriel (1948) reported favourably on the method though the two latter mentioned the possibility of a second carcinoma arising in the retained rectal stump and Lloyd Davies (1950) also drew attention to this danger Most surgeons in using Hartmann's technique have employed it as an *entirely intraperitoneal* operation with the retention of a fairly long segment of rectum and suture of its upper end For such cases at the present day an anterior resection with colo rectal anastomosis is likely to be preferred, and indeed I have thrice converted such cases to a sutured anatomosis between the iliac colon and the rectal stump with very gratifying results It is possible also to perform what may be termed an *extended Hartmann's operation* in which the entire rectum down almost to the ano rectal ring is removed leaving merely the anal canal No attempt is made to suture the upper end of the latter but instead the pelvic peritoneum is closed over the pelvic cavity and the anus is used to transmit the drainage tube This method may be useful occasionally as a means of terminating a rectal excision rapidly without the trauma of a perineal dissection in a patient whose condition during operation has suddenly deteriorated but in my experience it is liable to be followed by a rather prolonged convalescence due to inadequate drainage of the pelvic cavity For that reason when I have employed it, I have always divided the anal sphincters in the midline posteriorly

(*b*) *With anastomosis* In the early years of this century operations had been devised independently by Rutherford Morison (1910 Lockhart Mummery (1934) and Balfour (1910) for the resection of carcinomata of the recto-sigmoid region by an entirely abdominal approach with *restoration of continuity by a telescopic or tube technique* This involved tying a long stout, rubber or metal tube into the proximal stump of bowel and passing it into the distal stump and

through the anus By traction on the tube the bowel could be drawn into the upper part of the rectal lumen whilst sutures were inserted between the outer surface of the colon and the cut upper edge of the rectum When this row was completed further traction on the tube produced an infolding of the upper rectal margin and facilitated the insertion of yet another layer of sutures between the walls of the colon and rectum It is difficult to find adequate reports of the results of these operations but they were apparently followed by a considerable mortality and were soon abandoned But d Allaines (1956) still uses such a technique occasionally

The modern anterior resection with anastomosis has no connection with this tube technique and is completed entirely by suture It might be termed the Mayo Clinic operation or Dixon's operation for the credit for popularizing it undoubtedly lies with C F Dixon C W Mayo J M Waugh B M Black and E S Judd of the Mayo Clinic Wangensteen (1943 1945) has been another very influential advocate Certainly by this method it is possible to deal with practically all growths of the intra peritoneal part of the rectum and the recto sigmoid without having to resort to an abdomino sacral or anal technique to complete the anastomosis It is undoubtedly an advantage to be able to avoid these latter methods because after anterior resection healing of the anastomosis is more certain and due to the larger rectal stump retained the functional result is much better In my own practice and that of most other surgeons who undertake sphincter saving resections, it is only rarely now that other forms of resection are employed

PRESENT-DAY CHOICE OF RADICAL OPERATION FOR RECTAL CANCER

All researches into the mode of spread of carcinoma of the rectum are agreed in emphasizing the paramount importance of upward lymphatic spread along the superior haemorrhoidal and inferior mesenteric vessels In its radical removal therefore it is essential to excise these vessels with their accompanying lymphatics to as high a level as possible this implies the necessity for opening the abdomen for only through an abdominal approach can ligation of this vascular pedicle be effected at any point above the sacral promontory There are other advantages too in incorporating an abdominal phase in the operation It allows the surgeon to examine the arrangement of the vessels to the distal colon in order to assure himself that the colon stump has an adequate blood supply and to resect more bowel if deemed necessary It also enables him to assess more accurately the extent of spread of the growth and the prognosis and to undertake simultaneous resection of adherent viscera which would be im possible from below

Clearly the only operations that satisfy these requirements are a *combined excision* and *certain forms of sphincter saving resection conducted wholly or partly through the abdomen* and at the present time the choice of radical opera tion lies essentially between these two alternatives Theoretically there ought

perhaps still to be a place for simple perineal or sacral excision as procedures of lesser severity for certain poor risk subjects However, unless a surgeon is doing an operation fairly frequently he is not really in a position to exploit its safety to maximum advantage, and I doubt if the occasional perineal excision by someone who habitually employs combined excision is any safer than the operation with which he is more familiar

Combined Excision

This may now be regarded as the standard operation for most cases of rectal cancer The choice of technique from amongst the three main methods available—the Miles operation the perineo abdominal excision and the synchronous combined excision is a very personal matter in which the surgeon s training experience and natural bent must play a big part For that reason all three operations are described in subsequent chapters of this book

Extended Combined Excision

The ultimate value of *ligation of the inferior mesenteric vessels at the level of the origin of the artery* from the abdominal aorta, is still *sub judice*, but it is a rational extension to combined excision which my own experience and that of others has proved to be without additional risk My practice therefore is to tie the vessels at this level whenever it is easily possible to do so, but to accept a lower ligation in obese subjects or other patients in whom the additional exposure necessary for a high tie is difficult to secure and may add to the immediate hazards of the operation

On the other hand I have never been convinced of the value of *dissection of the internal iliac glands* on the pelvic side wall and am impressed by the increased haemorrhage and additional morbidity resulting from this step I have no hesitation in advising strongly against the adoption of this extension of combined excision as a routine manoeuvre

Resection of adherent small gut, uterus vagina seminal vesicles or ureter is employed freely as required but I must admit that I have been very guarded in my indications for *complete pelvic clearance* In my series of over 500 rectal excisions there have been only 10 pelvic clearances with 4 immediate deaths and no long term survivors In the more recent cases subjected to pelvic exenteration I have adopted the Bricker (1950) method of implanting the ureters into an isolated short loop of ileum draining to the surface as a urinary ileostomy

Resection with Restoration of Continuity

Till recently the place of sphincter saving resections in the radical treatment of rectal cancer has been one of the most controversial questions in surgery Most authorities such as Gabriel Abel, Lahey, Rankin Allen and Cattell shared the view of Miles (1910 1926) that lymphatic spread in this disease was liable to be very extensive and that complete excision of the rectum including the sphincters and levators was necessary for its eradication They were thus

reluctant to believe the subsequent findings of Westhues (1930 1933) and Dukes (1940) that spread seldom took place below the level of the primary growth or to accept that these provided a rational basis for sphincter preservation in the radical treatment of growths lying in the upper rectum or recto sigmoid But despite considerable opposition sphincter saving resections have been subjected to intensive trial in a number of centres in America and in this country during the past decade and it is now possible to make a preliminary assessment of their limitations and value

From my own experience I have no hesitation in saying that the best operation of this kind, *as regards immediate smooth convalescence and good post operative rectal function* is anterior resection with sutured anastomosis (Goligher 1958) Many other surgeons have reached a similar conclusion The next most useful type of conservative resection is abdomino anal excision by the Maunsell Weir (or Lloyd Davies) technique which is occasionally of value when anterior resection would not be technically feasible The recent comprehensive reports of Waugh Block and Gage (1955) Morgan (1955) Mayo and Fly (1956) and Mayo Laberze and Hardy (1958) seem to show beyond all reasonable doubt that sphincter saving resection is capable of yielding as good late results as does combined excision for carcinomata of the recto sigmoid and the upper and possibly the middle third of the rectum It may therefore now be regarded as an established surgical procedure in the treatment of growths in these situations However if disappointments are to be avoided in its application the utmost care must be exercised in the scope of the resection and the selection of patients for it, as emphasized in Chapter XVII

Choice of Radical Operation for Squamous Celled Cancer of the Anus and Anal Canal

Due to the strenuous advocacy of Gilchrist and David (1938) Gabriel (1941) Cattell and Williams (1943) Harvey (1946) and Sweet (1947) surgical excision has largely replaced irradiation in the treatment of this disease unless the condition is hopelessly inoperable Surgical excision may consist of a strictly local excision of the growth leaving the rectum and greater part of the anal canal or may include rectal excision by perineal or abdomino perineal route depending on the site and extent of the lesion and on the personal predilection of the surgeon concerned In planning surgical treatment a most important consideration is whether the growth extends upwards to involve the rectal mucosa proper or is confined to the peri anal skin and skin lined part of the canal below the pectinate line

Growths Extending Above the Pectinate Line

As Gilchrist and David (1938) and Gabriel (1948) have shown in dissected rectal excision specimens from patients with squamous celled carcinoma extending up to the rectal mucosa above the pectinate line spread is liable to occur in the rectal lymphatics and give rise to metastases in the glands on the back of

the rectum and alongside the superior haemorrhoidal or inferior mesenteric vessels Similarly extension *may take place via* the middle haemorrhoidal lymphatics to the internal iliac glands as emphasized by *Sauer and Bacon (1952)* There can be no doubt therefore that *a radical excision of the rectum preferably by the abdomino perineal method* is required exactly as in the treatment of a low rectal adeno carcinoma *In the performance of* this operation a wide margin of peri anal skin fat and muscle should be removed *in the perineal dissection* and in women the posterior vaginal wall should always be excised It is some times recommended that the greater part of this phase of the operation should be conducted with the diathermy electrode but it is difficult to discern any advantages for this technique over single scalpel dissection

With these growths lymphatic spread may also take place to the inguinal glands so that excision of these glands may also have to be considered as described below

Growths Situated Entirely Below the Pectinate Line

It is generally believed that the lymphatic drainage from the peri anal skin and the skin lined part of the anal canal below the pectinate line is exclusively to the inguinal glands and that proximal spread to the lymphatics of the rectum does not occur Consequently rectal excision is not usually considered necessary in the treatment of squamous celled growths that have not invaded rectal mucosa and surgical treatment has consisted of a wide local excision with sacrifice of some of the lower part of the anal sphincters but without removal of the rectum In the performance of local excision which may be performed with the cutting diathermy needle or the scalpel the surgeon should aim at a margin of clearance of at least ½ to ¾ inch on all aspects of the growth As a rule this is easily enough obtained except possibly at the upper border of the lesion which projects towards the anal canal *Unless* an adequate margin can be secured here between the growth and the pectinate line it is unwise to persist with a purely local removal instead a rectal excision should be carried out together with wide dissection of the tissues of the peri anal region on that side

Treatment of the Inguinal Glands

Though supervoltage radiotherapy teleradium or cobalt rays are favoured by some authorities it is probable that block dissection gives better results for the treatment of involved inguinal glands as with the cervical lymph nodes in cases of carcinoma of the lip or tongue I personally have reserved radiotherapy for cases with fixed inoperable glands

Indications for Block Dissection

(*a*) If on clinical examination the glands are obviously involved—that is to say if they are enlarged and hard rather than firm—a block dissection should be performed This operation is best postponed till the patient is thoroughly con valescent from the rectal or local excision of the primary growth or its radio-therapeutic treatment This usually imposes a delay of 5 or 6 weeks

(*b*) If the inguinal glands do not appear clinically to be implicated there are two possible courses of management as in the treatment of cancer of the lip or tongue According to our plan a conservative attitude is adopted in the first instance combined with a vigilant follow up to detect clinical signs of gland involvement at the earliest possible moment This implies frequent attendances by the patient for re examination because postal information from the patient or his doctor is apt to be unreliable He should report every month for the first 6 months and then every 2 months for another 2½ years or so If longer intervals are allowed to elapse it may be found that wide infiltration of the glands has occurred since the last visit even up to the extent of inoperability If it seems likely that the patient will not be able to attend regularly for review this expec tant regime should not be embarked upon At the first clinical evidence of lymphatic metastatic spread a unilateral or bilateral block dissection is performed

According to the other plan a prophylactic excision of inguinal glands is performed in all cases to ensure removing minute metastases that might later develop into clinically obvious deposits The disadvantage of this policy is that it subjects a number of patients to an unnecessary operation This would not matter if the operation were unassociated with serious post operative morbidity but that is not the case The immediate convalescence after block dissec tion of the groin glands may be prolonged by necrosis of the skin flaps and infection and there may be very considerable disability subsequently due to lymphoedema and gross elephantiasis of the leg and external genitalia I think that these disadvantages considerably outweigh the possible gain for provided supervision of the waiting regime is carefully conducted glandular involvement will still be detected at a relatively early stage and I doubt if the prognosis will be adversely affected by the slight delay entailed

Removal of a single gland or 2 or 3 glands for diagnostic purposes is not likely to be helpful If clinical suspicions of glandular metastases are roused it is better to proceed to a formal excision

Palliative Treatment of Incurable Cancer of the Rectum and Anal Canal

The following measures are available for the palliation of incurable growths of the rectum and anal canal

1 Palliative Excision

Unquestionably the most effective palliative measure available is excision of the primary growth if this is possible and fortunately there are few incurable primary carcinomata of the rectum that cannot be thus excised

2 Palliative Colostomy

In former years when the operability rate of carcinoma of the rectum was low it was customary to treat the inoperable cases by a loop iliac colostomy almost as a routine It was hoped that this operation would lead to an improve-

ment in the patient's general health and comfort by relieving any obstructive element It has to be admitted however, that in many cases, perhaps the majority, the operation afforded no worthwhile palliation and often made the patient a good deal less comfortable by simply adding the new burden of an artificial anus For unfortunately these discomforts especially the incessant spurious diarrhoea with passage of blood and slime, are directly attributable to the primary growth itself and can only be eliminated by its removal Realization of this fact has had two effects firstly it has induced the surgeon to undertake excision wherever possible, and secondly it has restrained him from performing a proximal colostomy unless the patient is in fact verging on acute obstruction In cases without complete or nearly complete obstruction it is better to leave the patient without a colostomy at first If acute symptoms develop later an emergency colostomy may be required but, this eventually seldom arises, more usually the patient dies of the general effects of his growth before this happens

3 Radiotherapy

Radiotherapy has an important role in the palliative treatment of cancer of the rectum and anal canal, and this is discussed in Chapter XIX

4 Curettage and Diathermy Fulguration

Sometimes patients who have an irremovable carcinoma of the rectum may be made more comfortable by curettage of a considerable part of the tumour with a large Volkmann's spoon *per anum* This treatment which naturally requires general anaesthesia, is more readily applicable to projecting growths which form a big intraluminal mass, for this may be steadily scraped away often with a considerable, though temporary reduction in the amount of discharge and bleeding There is obviously a danger of perforating the bowel if the curettage is continued too far, and the surgeon should be satisfied with modest gains at each session This palliative treatment may be used to supplement a proximal colostomy or as the sole form of therapy

Diathermy fulguration per anum is another method of achieving the same effect The growth is extensively destroyed *in situ* with the coagulating current of an ordinary surgical diathermy machine applied with a disc electrode or malleable blade under general anaesthesia If desired curettage and diathermy fulguration may be combined most of the obvious projecting tissue being first of all scraped away and then the remaining bared portion being coagulated with the diathermy For a period of 7–10 days after fulguration charred tissue sloughs away leaving a flat ulcer which sometimes heals completely Kergin (1953) of Toronto has reported some astonishing results with this method of treatment in 8 of 14 cases with inoperable growths treated by him the tumour had disappeared completely Many of the patients remained symptom free for periods of 2 and 3 years and 2 patients were alive and well more than 5 years later!

5 Intrathecal Injection of Alcohol or Phenol

One of the most unpleasant developments with an inoperable carcinoma of

the rectum is extension of the lesion to involve surrounding more sensitive parts such as the sacral plexus or the pelvis, with resulting severe sacral perineal or sciatic pain An attempt may be made to relieve this pain by intrathecal injection of alcohol to destroy the relevant posterior nerve roots The principle of the method is that the alcohol is lighter than the cerebro spinal fluid so that after the lumbar puncture needle has been introduced preferably through the first lumbar interspace, the patient is so positioned that the posterior nerve roots transmitting the pain lie above the point of the needle For full details of the method the reader is referred to Ottley (1938) or to standard neurosurgical texts In practice it is best to enlist the aid of a neurosurgical colleague in selecting patients for this form of treatment and in carrying it out Errors in technique may result in loss of control of the bladder sphincter

More recently phenol has been introduced as a substitute for alcohol for intrathecal injection by Nathan and Scott (1958) and Brown (1958) It has the advantage that it seems to have a selective affinity for sensory nerve fibres so that the risk of motor nerve injury with resulting paralysis is largely reduced

6 Chordotomy

As an alternative to intrathecal injections for intractable pain chordotomy may be employed and it will be for the neurosurgeon consulted to decide which if either of these operations is to be advised the tendency at the moment apparently being to try the more minor procedure of phenol injection in the first instance and to reserve the chordotomy for the cases that remain unrelieved by it

7 Sedatives and Other Symptomatic Measures

In the long run the majority of cases with inoperable, or recurrent rectal carcinomata require sedation and other symptomatic treatment for pain fistulous discharges and other complications of the disease as they arise

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CHAPTER XIV

ABDOMINO-PERINEAL EXCISION OF THE RECTUM

A. LAWRENCE ABEL

IN 1907 Ernest Miles, as a result of his researches into the lymphatic spread of the disease introduced the attack starting high up in the abdominal cavity so as to include the maximum upward, lateral and downward spread. Ever since I became associated with him I have used the abdomino perineal operation for the majority of cases. During recent years the resection rate has been 94 per cent. Less radical treatment is given only in 6 per cent of patients with cancer of the rectum.

Pre-operative Preparation

The bowel is prepared by saline aperients, colonic washouts and intestinal antibiotics. I prefer to use sodium sulphate by mouth in small quantities in fruit drinks several times a day, the total quantity in each 24 hour period being from 60–120 grains according to the degree of constipation. This salt, if administered carefully, produces a smooth soft motion once or twice a day without griping. Nurses are trained to give a copious plain water washout once a day. Rarely during the first 2 or 3 days two such washouts are needed. A very low growth may be too painful to allow such treatment and reliance must remain with oral salines.

After the first day or two the patient is given an intravenous injection of pentothal and a digital and sigmoidoscopic examination of the bowel is made with a biopsy of the lesion, the nature of which is always confirmed by microscopy.

Five days of treatment by sulphasuxidine or sulphathalidine has been used for many years, but recently guanimycin or 24 hour treatment with neomycin has proved equally, if not more, satisfactory.

The Anaesthetic

The patient is put to sleep in bed by an injection of omnopon 1/3 grain and scopolamine 1/150 grain. One hour later the anaesthetist gives pentothal and the patient is brought to the theatre unconscious. Then an intrathecal injection of 1 : 1,500 nupercaine is given and general anaesthesia continued with nitrous oxide and oxygen only. The introduction of these techniques has resulted in a great reduction of the mortality.

The Bladder

In all pelvic surgery it is important to ensure that the urinary bladder is

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CHAPTER XIV

ABDOMINO-PERINEAL EXCISION OF THE RECTUM

A LAWRENCE ABEL

IN 1907 Ernest Miles, as a result of his researches into the lymphatic spread of the disease introduced the attack starting high up in the abdominal cavity so as to include the maximum upward lateral and downward spread Ever since I became associated with him I have used the abdomino perineal operation for the majority of cases During recent years the resection rate has been 94 per cent Less radical treatment is given only in 6 per cent of patients with cancer of the rectum

Pre-operative Preparation

The bowel is prepared by saline aperients colonic washouts and intestinal antibiotics I prefer to use sodium sulphate by mouth in small quantities in fruit drinks several times a day the total quantity in each 24 hour period being from 60–120 grains according to the degree of constipation This salt if adminis tered carefully produces a smooth soft motion once or twice a day without griping Nurses are trained to give a copious plain water washout once a day Rarely during the first 2 or 3 days two such washouts are needed A very low growth may be too painful to allow such treatment and reliance must remain with oral salines

After the first day or two the patient is given an intravenous injection of pentothal and a digital and sigmoidoscopic examination of the bowel is made with a biopsy of the lesion the nature of which is always confirmed by micro scopy

Five days of treatment by sulphasuxidine or sulphathalidine has been used for many years but recently guanimycin or 24 hour treatment with neomycin has proved equally if not more satisfactory

The Anaesthetic

The patient is put to sleep in bed by an injection of omnopon 1/3 grain and scopolamine 1/150 grain One hour later the anaesthetist gives pentothal and the patient is brought to the theatre unconscious Then an intrathecal injection of 1 1 500 nupercaine is given and general anaesthesia continued with nitrous oxide and oxygen only The introduction of these techniques has resulted in a great reduction of the mortality

The Bladder

In all pelvic surgery it is important to ensure that the urinary bladder is

empty Therefore after the patient has been anaesthetized, an assistant should pass a catheter and empty the bladder With normal abdominal relaxation there is a negative pressure in the abdomen and gentle but firm suprapubic pressure is needed which must be continued while the catheter is being withdrawn otherwise the bladder fills with air which makes deep pelvic dissection as difficult as if it were full of urine

In the male a 25 cm piece of adhesive should be attached from one thigh to the other below the level of the pubis so that the genitalia are controlled when *the patient is subsequently tipped into a Trendelenburg tilt*

Incision and Abdominal Exploration

Having tried left central and right vertical and left oblique muscle splitting incisions I am of opinion that the most satisfactory is a long right paramedian incision extending from 2 5 cm above the umbilicus to the pubis It should be about 1 5 cm from the midline The vulnerable tissue with regard to infection is the subcutaneous fat, therefore attach tetra cloths to the cut edges of the rectus sheath to protect it Retract the right rectus abdominis muscle to the right and incise the posterior sheath and peritoneum 2 cm from the midline

Having opened the abdomen make a careful and thorough abdominal exploration without however manipulating the rectum with its contained growth because cancer cells may be forced into the blood stream This is one reason why I do not have another surgeon working in the perineum Take special care in the palpation of the liver to ascertain if metastases are present It used to be said *that cases which at the time of laparotomy were found to have obvious* hepatic metastases should be treated by colostomy alone However, in 1931 I had the privilege of meeting Dr Daniel Fiske Jones of Boston He told me of the great benefit and prolongation of life that these patients received if a full abdomino perineal excision was carried out Since then the majority of my cases with hepatic metastases have been treated by the radical operation They are of course incurable but they live much longer than those cases in which the primary lesion is left *in situ* The majority live free of pelvic complications and have a *painless death I have seen many live over 5 years, one for 8½ and one over* 12 years

The exploration made insert a wide self retaining retractor pack the intestines into the upper abdomen with large packs moistened with saline solution and tip the table into a high Trendelenburg tilt (60°–70°)

Mobilization of Pelvic Colon

Draw the pelvic colon to the right This reveals the bloodless white line where the hindgut rotated and joined the parietal peritoneum—the zygotic plane The first step is to divide the adhesions which always exist between the left side of the pelvic mesocolon and the left iliac parietal peritoneum Carry this peritoneal incision downwards obliquely to the recto vesical or recto vaginal pouch still in the zygotic plane To the outer edge of this cut peritoneum attach 3 or 4 Kocher forceps and retract it to the left Blunt dissection with a small

gauze swab on a long forceps (the use of which I learned from Dr Frank Lahey in Boston in 1931) is very satisfactory for performing bloodless dissection of the left iliac fossa and left wall of the pelvis The left ureter is immediately seen with the spermatic (or ovarian) vessels to its outer side The ureter should be gently traced along the side wall of the pelvis downwards for 3 or 4 inches Behind the ureter define the bifurcation of the left common iliac artery and its two branches

The Internal Iliac Arteries

Separate the anterior division of the internal iliac artery from the big internal iliac vein behind it by blunt dissection The posterior division has, of course come off at or just below the bifurcation of the common iliac and gone backwards through the great sacro sciatic notch Pass a catgut ligature on an aneurysm needle around the anterior division of the internal iliac artery and ligate it in continuity

Now draw the pelvic colon to the left and make an incision through the peritoneum forming the right leaf of the pelvic mesocolon at its origin from the posterior abdominal wall and front of sacrum Carry this incision obliquely downwards to reach the recto vesical or recto vaginal pouch as on the left side Use Kocher forceps to draw the outer edge of this incised peritoneum to the right Again employ blunt dissection of the region thus exposed Define the bifurcation of the aorta the right common iliac artery and its bifurcation See the external iliac artery and the anterior division of the internal iliac artery Separate the latter from its underlying vein and ligate it as on the left Always define the right ureter which can be found a little to the right of the right common iliac artery It should be traced downwards beneath the peritoneum to its entry to the bladder but its blood supply must not be interfered with

Ligature of the anterior divisions of the internal iliac arteries whilst not an essential step in the average case nevertheless does prevent bleeding from the middle haemorrhoidal arteries However, if the uterus or bladder has to be removed at the same time as the rectum it is a most valuable step Miles used it invariably for a Wertheim s hysterectomy I have done it for many years both for a standard abdomino perineal excision and when an abdomino perineal and a Wertheim have to be carried out together It is also invaluable when the prostate or prostate and bladder have to be removed with the malignant rectum *i e* in cases of total pelvic clearance

The Inferior Mesenteric Artery

The next key point in the operation is ligature of the root of the pelvic mesocolon with its contained inferior mesenteric artery vein and lymphatics Get the assistant to pull the pelvic colon well downwards Pass a Reverdin needle around the root of the pelvic mesocolon just above the level of the bifurcation of the abdominal aorta This is the site of election or *pointe critique* By means of this needle or an aneurysm needle pass a stout ligature of chromic catgut and tie it firmly I call this the Rubicon ligature because once it is tied

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there is no turning back, because the blood supply to the lower sigmoid and rectum is cut off. Pass and *tie a second ligature 2.5 cm below the first to prevent back-flow.* Cut through the root of the pelvic mesocolon between these two ligatures. In the proximal stump the *inferior mesenteric artery can always be seen projecting.* Tie another ligature around it.

The Pelvic Peritoneum

The *incision of the root of the pelvic mesocolon should be found to be continuous* with the incisions already made on each side of the pelvic mesocolon and all that remains to free the rectum entirely from its peritoneal attachments is to join the two lateral incisions by cutting the peritoneum where it lies over the recto-vesical pouch in the male, or the vault of the vagina in the female.

Pass the fingers behind the root of the pelvic mesocolon and into the hollow of the sacrum. Strip the rectum and all the retro-rectal fat and lymphatic glands contained in the fascia propria of the rectum from the front of the sacrum down to the coccyx. *The clean shining periosteum of the sacrum is the indication that the stripping is in the correct plane.*

The Lateral Rectal Ligaments

The *only structures which remain attaching the rectum to the lateral walls of the pelvis are the lateral ligaments.* On drawing the pelvic colon and rectum towards the right the left lateral ligament of the rectum becomes apparent. This is situated below the line of the left ureter, and is a dense fascial structure continuous with the fascia of the obturator internus muscle and the fascia of the upper surface of the levator ani muscle. *Use a Mayo type scissor of 14 inch length in order to divide it.* Cut carefully between the ligament and the lateral *wall of the pelvis, taking care not to damage the big blood vessels which lie close to the lateral pelvic wall.* Carry the incision downwards to include the *fascia of the obturator internus and the upper surface of the levator ani, the fibres of which can clearly be seen in the depth of the pelvis.* Then draw the pelvic colon and rectum towards the left and carry out a similar dissection on the right side. The rectum is now freed on both sides down to the levatores ani muscles.

Now the rectum must be *mobilized anteriorly* by a combination of blunt and sharp dissection between the fascia of the rectum posteriorly and the fascia enclosing the seminal vesicles (or vagina) anteriorly. The line of incision through the peritoneum which covers these structures has already revealed them and a small gauze swab *on a long pair of forceps readily* dissects this fascial plane. Only in tough fibrous cases are the long scissors necessary. A few moments' perseverance enables the seminal vesicles to be pressed forwards away from the rectum down as far as the posterior aspect of the upper part of the prostate in the male. In the female, dissect the posterior wall of the vagina from the front of the rectum for 2 or 3 inches. Thus the pelvic colon and rectum are now free down to the prostate (or vagina) in front, to the levatores ani laterally and to to the coccyx posteriorly.

Division of the Mesocolon

Starting at the main or Rubicon ligature divide the pelvic mesocolon antero laterally towards the edge of the bowel The line of incision should be at right angles to the inferior mesenteric artery and also at right angles to the colon The importance of this is that as much as possible of the dangerous pelvic meso colon and also the greatest possible length of pelvic colon with its paracolic lymph nodes potentially bearing cancer cells are removed As the incision of the mesocolon is being made one or two blood vessels are always seen, except in a very fat subject These may be picked up before they bleed Their presence shows that there is a good collateral circulation to the part of the bowel which is to form a terminal colostomy or artificial anus The length of pelvic colon which it is necessary to retain is enough to reach comfortably without kinking and without leaving any redundant loop from the left iliac fossa to about 1 inch outside the skin in front of that region

Division of the Bowel

Pass a Zachary Cope modification of the Martell three bladed clamp around the bowel and close it Remove the middle of the three blades Divide the bowel between the two remaining blades with the cautery or surgical diathermy Cultures taken from many of these incised surfaces have proved sterile Nevertheless to be quite safe put a previously prepared plastic cap with an elastic neck over each end of the Cope Martell blades A similar cap may be made from rubber sheeting The whole mass of pelvic colon mesocolon and rectum is now freed except in the perineum and should be tucked downwards into the hollow of the sacrum At this stage the median sacral artery and vein are seen or felt lying on the sacral promontory Pass a catgut ligature on a needle around these vessels and tie in continuity This step prevents much of the bleed ing which occurs in the posterior part of the perineal portion of the operation and especially in those which have such a massive tumour that the coccyx has to be excised also Fortunately it is very rare to have to remove the coccyx

The New Pelvic Floor

Now fashion the peritoneum of the pelvis to make a new peritoneal floor to close the pelvic portion of the abdominal cavity In the previous dissection some of the peritoneum of the side walls of the pelvis has already been mobilized Pick it up again with Kocher forceps Also pick up the cut edge of the peri toneum which lies over the base of the bladder in the male In the female the corresponding cut edge of peritoneum is the posterior edge of the posterior leaf of both broad ligaments Gently strip and tease this peritoneum upwards and forwards by blunt dissection using the fingers and Lahey swabs As this strip ping is performed in the male the vas deferens is seen on each side wall of the pelvis The suspensory ligament of each is found together with the peritoneum at that spot Make a few sweeps with the swab to free it and continue the dis section until sufficient sheets of peritoneum are obtained with which to close the pelvic floor In elderly subjects divide each vas for the same reasons as when

performing prostatectomy In the male there have now been formed three flaps —one from each side-wall of the pelvis and one from the dorsum and base of the bladder The two former are crescentic in shape and the latter triangular Make sure that it is dissected upwards enough to enable it to reach the root of the pelvic mesocolon at the site of the 'Rubicon ligature without tension In the female two broad flaps have been formed each continuous with the back of the cervix anteriorly The right hand flap runs directly backwards to the Rubicon ligature On the left it runs to the wall of the colon at the place where the latter leaves the iliac fossa to pass forwards to its termination Here there is a bare area of colon and the peritoneum on its medial side runs for a further inch or two to meet the Rubicon ligature

To close the pelvic floor use a continuous interlocking catgut stitch In the male first suture the centre or apex of the central flap to the peritoneum just in front of the 'Rubicon ligature There is now a V shaped gap to be closed Extend the suturing to the wall of the pelvis on the right side carefully everting the rough edges of peritoneum towards the pelvis so that the abdominal side is smooth On the left start anteriorly and continue suturing as before Take care where the suture goes round the root of the bowel to avoid including any of its blood vessels in the stitch, and continue until the site of the Rubicon ligature is reached When this suture is finished the pelvic space is completely separated by the new peritoneal floor from the abdominal cavity In the female, suture the two lateral flaps from the back of the cervix uteri to the peritoneum at the site of the Rubicon ligature

If the patient has an appendix remove it at this stage of the operation Remove the self retaining retractor and the abdominal packs

The 'Artificial Anus' (or Colostomy)

The proximal end of the colon with its attached clamp and cap must now be brought through the anterior abdominal wall At a point one third of the distance between the left anterior superior iliac spine and the umbilicus pick up the skin with a forceps and excise a circle of it 2 5 cm in diameter Stab through all layers of the abdominal wall making an incision of 3 or 4 cm Put two fingers into this opening and stretch it Pick up the peritoneum at the edge of this incision with forceps at the four points of the compass Draw out the bowel which should be found to project about 2 5 cm

Now return to the abdominal cavity and close the gap between the last few centimetres of the pelvic colon and the posterior aspect of the abdominal wall and the peritoneum of the left iliac fossa Use an interlocking catgut stitch to close this gap This avoids the possibility of a knuckle of bowel passing into this fenestrum and becoming strangulated It is interesting to note that if this gap is not closed and if a knuckle of small intestine does pass through it it usually goes from below upwards and not from above downwards

Closure of the Abdomen

Close the peritoneum with catgut the rest of the abdominal wall with

stainless steel wire The latter was brought to my attention by Dr Thomas E Jones of Cleveland, Ohio 20 years ago, and I have used nothing else since for closing major abdominal wounds If the patient is thin use interrupted stitches, if fat, continuous In either case the far and near stitch which Alan Hunt and I (1948) described 12 years ago is used, the far stitch takes a bite of the linea alba and about 2 5 cm of rectus muscle then the near stitch the two adjacent edges of the anterior rectus sheath making a figure of 8 As it is preferable not to have stitches through skin use Michel clips to appose the skin edges

Fashioning the 'Artificial Anus' (or Colostomy)

The final stage in the abdominal portion of the operation is the important treatment of the last few centimetres of the colon in order to prevent peri colostomic herniation

Years ago when only one stitch was placed above and one below between the skin and the bowel large herniations were common To avoid this complication insert three layers of catgut suturing first between the wall of the bowel and the peritoneum of the abdominal wall second between the anterior aponeurosis and the wall of the bowel and finally place eight stitches accurately to appose mucosa and skin With this care the artificial anus retains its wide opening and stenosis and contraction once frequent, are now rare

This artificial anus or colostomy is normally flush with the skin and is quite different from the projecting colostomy of former years The former term is therefore preferable to the latter—a term popularly associated with an incurable disease

The Perineal Portion of the Operation

Place the patient in the right lateral position

Cleanse a wide area of skin of the perineum with a mercury lotion Miles taught for very many years that 1 500 perchloride of mercury not only destroys pyogenic organisms but also cancer cells both of which may be present on the peri anal skin

Close the anus with a purse string suture and treat again with mercury

The Incision

Use a Miles s original incision—a figure of 6—starting to the side of the sacro coccygeal joint and including a wide area of peri anal skin Deepen it to divide the ischio rectal fat close to the ischia and inner borders of gluteus maximus muscles Insinuate the knife immediately below the coccyx to enter the pelvic space and sweep it laterally to divide the levator ani muscle close to the wall of the pelvis on both sides as far forwards as the prostate Occasionally a small pelvis or a large rectal tumour necessitates removal of the coccyx Insert the fingers into the sacral hollow and draw out the bowel

On account of the extent of the dissection previously carried out from the abdominal aspect all that remains is to dissect the lower third of the rectum and the anal canal from the prostate or posterior vaginal wall and base of the

triangular ligament Avoid damage to the bulb of the urethra which should not have an indwelling catheter because the latter renders it more liable to injury

Carefully secure all bleeding points

The Toilet and Closure

The pelvic cavity remaining is relatively septic because of the disruption of innumerable lymphatics potentially bearing organisms and cancer cells Therefore swab it out with 1 500 perchloride of mercury and follow this with normal saline Cover the wound with a layer of oiled silk into which pack 1–2 yards of sulphonamide impregnated gauze Leave the end of the pack protruding Only the subcutaneous tissues and skin can be apposed Place a few deep and some more superficial interrupted catgut sutures in the subcutaneous fat Insert 2 or 3 short subcuticular stitches to appose the skin This has been found to be the most comfortable type of stitch, and enables the patient to sit in a chair from the first post operative day

Give a blood transfusion at or towards the end of the operation and follow this with intravenous infusion of 4 3 per cent Dextrose and 0 18 per cent NaCl until the bowel acts

Before the days of antibiotics and modern anaesthesia the operative mortality was due to infection, pulmonary complications peritonitis paralytic ileus and urinary infection Shock in those days was a big factor Today the majority if not all of these have been eliminated and the mortality is almost limited to diseases which are as yet difficult to avoid such as coronary catastrophe, pulmonary embolism, and only rarely infection

Lastly it is heartening to recall that out of more than 1 400 operated cases many who appeared to be in an advanced stage of the disease and whose pathological report indicated a grave prognosis after an abdomino-perineal excision, still attend for follow up inspections twenty, twenty five and even thirty years later

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CHAPTER XV

PERINEO-ABDOMINAL EXCISION OF THE RECTUM

WILLIAM B GABRIEL

THIS operation is carried out in one stage without a preliminary colostomy A pre operative course of one of the bowel sulphonamides such as sulphasuxidine or sulphathalidine is not given as a routine but is reserved for cases in which offensive loose stools have been noted before operation and might be troublesome after operation or a danger to wound healing also in cases of polyposis with carcinoma and in male cases with a deeply ulcerated growth anteriorly which might possibly perforate at the base in the course of dissection from the prostate or urethra The most essential point in preparation of the bowel is for the patient to come to operation with no fluid content in the rectum The last preparatory enema is given on the evening before operation and a flatus tube is passed per rectum 2 or 3 hours before operation but no enema or washout is administered on the morning of operation Some faecal masses in the colon even a gross faecal impaction above a recto sigmoid carcinoma do not constitute either a handicap or a danger in this operation

Anaesthesia is a straight general given on modern lines with intubation supplemented by one of the muscle relaxants such as Tubarine or Flaxedil In addition I usually carry out a quick infiltration of the abdominal wall with 1 per cent procaine after the abdomen has been opened Spinal anaesthesia has been discontinued in my series since October 1949 and I feel sure that we have done better and have had less anxiety since it was dropped

During the last 3 years 1956–58 one of my anaesthetic colleagues (Dr F E Clynick) has introduced me to epidural anaesthesia and this has now been given for 32 perineo abdominals without mortality 12 of these patients were aged 70 or over The solution injected into the epidural space has been the standard Xylocaine Nupercaine mixture (equal volumes of 2 per cent Xylocaine and 1 in 600 Nupercaine) the dose given varies between 28–35 ml This anaesthetic seems to be specially indicated in the thick set short necked individual and it matters little what the initial blood pressure may be, some fall in blood pressure is inevitable but this actually proves to be an asset when the perineal stage of the operation is being carried out Other advantages are that the abdominal wall is perfectly relaxed and from the patient s point of view it must be a benefit to be lying quietly on the operating table breathing good fresh air rather than having an endo tracheal catheter attached to a machine After an epidural anaesthetic it is our usual practice to have the foot of the bed raised on 6 inch blocks until the following day or until such time as the blood pressure has returned to normal or almost normal

The following stages are to be noted

First Stage

A right paramedian laparotomy is done to confirm operability The liver is carefully palpated and the rest of the colon is examined The exact situation and size of the growth are determined and involvement of other organs such as the uterus or small intestine is specially to be noted

In advanced cases in the male when there may be some doubt whether the bladder is involved, it is a good plan to take a long-handled scalpel and make a short transverse incision through the peritoneum of the recto vesical pouch and then by inserting a finger or an empty sponge holding forceps one can quickly determine if the base of the bladder is free from extension of the growth This preliminary incision of the pelvic peritoneum from above is also useful in women who have previously had a hysterectomy because as a result the level of the peritoneum may have been raised and it may be difficult to open it from below If conditions are suitable for the operation to be proceeded with I ask the assistant to hold out the pelvic colon with his left hand while I inject 10 ml of 1 per cent procaine solution into the base of the pelvic mesocolon (taking care not to prick a vessel) in order to block ascending impulses during the perineal stage The abdominal wound is closed temporarily with 4 or 5 stout silkworm gut sutures tied over a piece of gauze The wound is covered with a temporary dressing and a sterile towel laid over is kept in position with 2 pieces of broad adhesive strapping

Second Stage

This is the perineal stage The patient is turned on to his left side and the anus is closed securely with 2 purse string sutures of stout silk a piece of dry gauze having first been tucked into the anal canal and lower rectum in order to prevent leakage of mucus during the operation A formal perineal dissection then follows as described by my chief J P Lockhart Mummery and depicted in the second edition of his book (1934) Before opening the peritoneum the rectum is encased in a sterile rubber glove which is tied on tightly with two stout silk ligatures The peritoneal pouch is then incised anteriorly and when the glistening peritoneum is seen the scissor cuts are taken up the sides of the pelvic mesocolon left and right, as far as can be reached with blunt ended straight scissors (7½ inches or 20 cm in length), this is the only special instrument required for this operation the rest being routine surgical equipment such as is in universal use The lateral ligaments are, of course divided at this stage and the middle haemorrhoidal arteries only need ligation in less than 50 per cent of cases If a thickened cord is clearly felt laterally in the course of the rectal mobilization this is fairly certain evidence that middle haemorrhoidal spread has taken place special care can then be taken to dissect the lateral ligaments as far as possible laterally with due care for the related ureter In such cases I usually ligate the middle haemorrhoidal pedicle by use of an aneurysm needle and No 1 catgut and then divide the pedicle close to the ligature with cutting diathermy

When the rectum has been fully mobilized it is swabbed over with saline lotion and is pushed up into the pelvis with the aid of a gauze swab or sponge-

holding forceps The lower end of the peritoneal pouch anteriorly is then taken in artery forceps and the peritoneal stitch is begun from below After 3 or 4 bites the needle is passed through a small gauze swab, the excess of catgut is wound round it and it is then passed up into the pelvic cavity The perineal wound is closed anteriorly and posteriorly drainage being effected by a short piece of rubber tubing inserted through the middle third of the wound It is not necessary to support the reformed pelvic floor with any sort of packing

Third Stage

This is the final abdominal stage The abdominal wound is reopened and the mobilized rectum is delivered through it The pelvic mesocolon is incised upwards on each side and the main ligature of silk is then applied to the inferior mesenteric pedicle above the first sigmoid branch An oblique incision is made in the left iliac fossa of sufficient length just to permit the mobilized rectum and pelvic colon to be passed through care being taken that the bowel is not twisted and that no awkward loop of pelvic colon is left inside the abdomen the lateral space is in all cases closed by a catgut suture to prevent small gut herniation through it

The stitch closing the peritoneal pelvic floor is run upwards and with an empty pelvis this is usually very easy In young subjects it is advisable to remove the appendix to prevent risk of acute appendicitis later and at any age this should be done if the appendix is found to contain faecoliths or looks unhealthy

The paramedian incision is closed in layers with a continuous No 35 monofilament wire suture for the anterior rectus sheath The colon is placed at the upper end of the left oblique wound which is closed in layers a few interrupted sutures of fine braided steel wire are inserted into the external oblique at the lower end of the wound and sufficient space should be left to allow a forefinger to be passed in alongside the emerging colon In order to prevent the sharp edge of the external oblique from compressing the colon it is advisable to make a short relieving incision through the fibres of the external oblique on both the medial and lateral aspects The wound is closed suitably with interrupted nylon sutures and a strip of skin is excised with scissors on each side in order to minimize the risk of skin stenosis developing later The marginal artery to the emerging iliac colon is ligated about 5 cm distal to the skin level and 2 pairs of Parker-Kerr forceps are applied to the colon at this level Two layers of gauze are placed on each side of the colostomy and are kept in position with Michel clips The bowel is then divided with a cautery in between the Parker Kerr forceps The proximal one is removed and after opening up the bowel lumen a soft rubber catheter is inserted and fixed with a stitch in order to decompress the colon a few ounces of olive oil are run in with the object of lubricating the colon and softening faecal masses The operation is thus completed and no further turning is needed

The advantages of this operation are as follows

1 It is a straightforward radical operation in which the important perineal dissection is done early in the operation by accurate dissection a careful attack on the middle haemorrhoidal pedicle can be made when specially indicated

2 The pelvis is cleared from below upwards which is a great advantage especially in men with a massive growth in a narrow pelvis There is never any need to cut the bowel across to reduce the size of the specimen as sometimes proves necessary in the classical abdomino perineal excision The perineo abdominal operation is very good also for cases with a short pelvic colon and a number of my cases have shown specimens varying in length from 12 to 14 inches measured from the anus to the left iliac colostomy, in these cases the rectum and recto sigmoid are usually very wide and massive but this makes no difficulty when tackled by the perineo abdominal route

3 The entire rectum and pelvic colon are removed intact up to a left iliac colostomy

4 There is no intraperitoneal division of the bowel and this is of importance when the pelvic colon is massively involved with diverticulitis In the perineo abdominal operation the colon is exteriorized unopened up to a colostomy stoma in the iliac colon but if considered necessary for instance in a case where a second carcinoma is discovered in the descending colon and in cases of poly posis the splenic flexure can be mobilized thus completing a left hemicolectomy, in which case a terminal transverse colostomy is then made, preferably through a short separate incision

5 A steep Trendenlenburg tilt is not required, in most cases a 10° tilt is all that is needed for the final abdominal part of the operation with 15° or pos sibly 20° for a few minutes when the pelvic floor is being closed This is of great importance when aged or stout subjects are being operated upon respiratory embarrassment and cardiac congestion may easily be set up by a lengthy period in a steep Trendelenburg tilt and this can definitely be avoided by the perineo abdominal operation

6 A swiftly performed operation is of major importance especially when as so often happens we have to operate on subjects of over 70 or even 80 years of age with rectal cancer With good theatre teamwork and a reasonably easy case my operating time is usually about 1½ hours or less but may be extended to 2 hours in a fat difficult subject The additional time from commencement of the anaesthetic to the abdominal incision is often only 7 to 8 minutes Since 1952 I have done a perineo abdominal incision for 87 patients in the age group 70–79 and for 8 who were aged 80 or over the oldest being 87 this last patient a woman with auricular fibrillation made a good recovery

Operative Mortality

The operative mortality in my total series of 1 328 perineo abdominal excisions for malignant disease (1932–60) is shown in Table XV The steadily decreasing operation mortality is evident and it has dropped from 26 per cent 25 years ago to 4 8 per cent in the last 4 years This is to be attributed to increas ing experience more careful pre operative assessment the use of stainless steel wire for the abdominal wall greatly improved anaesthetic methods and the use of antibiotics and sulphonamides when indicated Also the early recognition and treatment of post operative thrombosis has been very important

TABLE XV

One Stage Perineo Abdominal Excision for Malignant Disease of the Rectum and Anal Canal

Operation Mortality since 1932

Total Series — 1 328 Cases

Period	*Number of cases*	*Operative deaths*	*Operation mortality (per cent)*
1932–36	81	21	26
1937–46	517	58	11
1947–56	625	33	5 3
1957–60	105	5	4 8
Total	1328	117	8 8

The great advantages of teamwork and of collecting cases of rectal cancer into a special clinic are shown in Table XVI which indicates that my mortality in St Mark s Hospital during the last 14 years (502 operations) amounts to 2 6 per cent At one time I had 168 cases without a death In the same period the mortality in 228 operations done in other hospitals or clinics has been 25 deaths—10 9 per cent

TABLE XVI

One Stage Perineo Abdominal Excision of the Rectum for Malignant Disease of the Rectum and Anal Canal Radical and Palliative

(St Mark s Hospital)

1947–60

Period	*Number of cases*	*Operative deaths*	*Operation mortality (per cent)*
1947–51	223	8	3 6
1952–56	199	3	1 5
1957–60	80	2	2 7
Total	502	13	2 6

End Results

The 5 year survival rate depends on the stage of the disease and one of the great benefits conferred by Dukes s classification into A B and C groups is that statistics can now be made comparable

Table XVII shows the 5 year survival rate of cases operated upon up to December 1953 It is evident that the C cases outnumber the A and B cases combined and in fact constitute 53 5 per cent of the total cases In the A and B groups the crude 5 year survival rate was 83 6 per cent and 64 4 per cent respectively, but in the C group it fell to 32 6 per cent The aggregate figure for the A, B and C cases combined is exactly 50 per cent

TABLE XVII

Five-year Survival-Rate following Perineo Abdominal Excision of the Rectum for Malignant Disease of the Rectum and Anal Canal

(*Comprising all cases operated upon from January* 1932 *to December* 31, 1953)

Group	*survivors Number of operation*	*Untraced*	*Died of other causes in less than five years*	*Died of cancer in less than five years*	*Alive at five years*	*Percentage of five year survivors*
A	134	1	13	8	112	83 6
B	315	0	31	81	203	64 4
C	515	1	30	316	168	32 6
Total	964	2	74	405	483	50

This final figure is of course adversely affected by the high operability (resectability) rate of over 90 per cent which is now achieved and I have made no attempt to divide the series into favourable and unfavourable groups, many of the advanced growths were locally inoperable and the operation could only be regarded as palliative In addition there were no fewer than 46 cases with liver or other distant metastases at the time of operation *i e* they were Stage IV cases in which a long survival could not be expected in such cases however a radical operation often proves well worth while not only from relief of rectal symptoms and freedom from chronic intestinal obstruction but there is a psychological benefit and possibly some increase in length of life

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CHAPTER XVI

SYNCHRONOUS COMBINED EXCISION OF THE RECTUM

O V LLOYD DAVIES

IN this operation both the abdominal and perineal fields are exposed at one and the same time It is a team operation two surgeons working synchronously one from the abdominal aspect and the other from the perineum

The patient is placed in a modified lithotomy position by using special leg rests (Lloyd Davies 1939) which allow of extension of the thighs away from the abdomen The sacrum is raised upon a sandbag or sacral rest (Goligher 1949) so that the sacro coccygeal region projects over the end of the table giving an adequate exposure of the coccyx for the perineal operator The rest also tilts the pelvis anteriorly and thus lessens the degree of Trendelenburg tilt required by the abdominal operator

A small lumbar air cushion is used to eliminate undue kyphosis and Frankis Evans epaulette shoulder rests are advised to prevent damage to the brachial plexus

H I omnopon gr 1/3 and scopolamine gr 1/150 are given one hour before the operation and anaesthesia induced with thiopentone followed by gas and oxygen with muscular relaxants and further thiopentone when necessary

As soon as the patient is anaesthetized a plastic or latex rubber catheter is passed and complete emptying of the bladder ensured by firm suprapubic pres sure which should be sustained until the catheter is spigotted thus preventing air entering the bladder and reducing the available working space in the pelvis

In males the catheter is tied in or preferably, a self retaining Foley catheter used and the penis and scrotum strapped to the right thigh

An intravenous infusion is essential and is set up before the start of the operation using normal saline and blood during the operation and one fifth normal saline (0 18 per cent saline 4 3 per cent dextrose) post operatively

A long left paramedian muscle sliding incision has been found to give the best exposure The abdomen is systematically examined commencing with the liver and concluding in the pelvis The position size and fixity lymphatic and peritoneal spread are assessed and a decision made upon the operability and type of operation required Growths situated at and above the pelvic peritoneal reflection may frequently be dealt with radically by a restorative resection (*e g* anterior resection) Growths situated below the peritoneal reflection require a combined excision to give the patient the greatest possible chance of cure

Regarding liver metastases it has been found to be a definite benefit to proceed with the excision of the primary growth to prevent sacral pain and rectal discharge provided the liver is not grossly involved and enlarged by the deposits

Regarding fixity, no case should be abandoned *until trial dissections* have been made upon the fixed aspects of the bowel because fixity is frequently due to peri rectal inflammation

Following the assessment of the case both operators commence the dissection but the abdominal aspect will be described first

The first step is the careful freeing of the iliac colon from the left iliac fossa This part of the colon is always found to be partially fixed by a variable number of adventitious peritoneal folds Their attachment to the lateral aspect of the mesocolon is indicated by a whitish serrated line Division of these folds at the apex of their attachment is carried out with a pair of light curved dissecting scissors until the full length of the mesocolon is exposed In this way sufficient peritoneum will be preserved to cover the upper part of the pelvic floor at the end of the operation

An incision is now made on the lateral aspect of the base of the mesocolon as it crosses the common iliac vessels and the left ureter is exposed A finger placed over the ureter sweeps it away from the posterior aspect of the mesocolon and prevents any possibility of its being included in the main ligature The vessels to the pelvic mesocolon which are often very variable are now inspected and the site of division of the main pedicle selected

To obtain a greater removal of the upward lymphatic field it is now a common practice to divide the inferior mesenteric artery at its origin from the *aorta and the inferior mesenteric vein at the inferior border of the pancreas and* particularly so when palpable lymphatic metastases are detected in the mesorectum or colon

Before embarking upon this step it is important to see that there is an adequate blood supply from the middle colic vessels and in obese subjects and those with atheromatous changes it may be advisable to divide the main inferior mesenteric trunk at a lower level below the left colic artery

The peritoneum on the medial aspect of the mesocolon is now divided from just below the sacral promontory to the site selected for ligature

The mesentery is now elevated from the anterior surface of the aorta with the finger and the inferior mesenteric vessels are isolated and divided between stout ligatures

The division of these vessels is made at this early stage in the operation before any mobilization *of the primary tumour has taken place in order to* prevent the possibility of neoplastic emboli reaching the liver as the result of *manipulation of the bowel*

The pelvic dissection is commenced by lifting the recto sigmoid angle forwards *from the promontory* of the sacrum and inserting a pair of blunt nosed scissors downwards and backwards immediately in front of the first piece of the sacrum and behind the mesorectum A presacral plane of cleavage is thus produced The fingers and finally the whole hand are inserted into this presacral space and the mesorectum deliberately pushed forward from the front of the sacrum and lateral pelvic walls as far downwards as the coccyx any tough strands of fascia being divided with scissors By sweeping the hand from side to side the posterior aspects of the upper parts of *the lateral ligaments are made prominent*

At this stage the abdominal and perineal dissections meet behind the meso rectum the rectum being completely freed posteriorly

The peritoneum and subperitoneal tissues are now incised widely on either side of the bowel as far down as the peritoneal reflection and the two incisions are joined anteriorly just in front of the peritoneal pouch The course of the ureters must be carefully noted at this stage and in cases of bulky tumours in the mid pelvis both ureters should be exposed throughout their course to the bladder

In males the apex of the incised peritoneum is drawn upwards and the posterior surface of the vesicles exposed by blunt nosed scissors dissection In so doing the fascia of Denonvilliers is frequently found to be incised, alternatively if the fascia is stout it may be seen lying between the anterior surface of the rectum and the base of the vesicles and is incised transversely Following this a distinct plane of cleavage extending down to the apex of the prostate will be found with the fingers

Whilst in the space the fingers are swept laterally to define the anterior borders of the lateral ligaments Each lateral ligament is in turn made taut by displacing the rectum to the opposite side with the left hand and divided with scissors well out on the pelvic wall and as far downwards as possible Any remaining portions will be divided by the perineal operator The middle haemorrhoidal vessels will require ligation

In females in order to make the operation as radical as possible it is customary to remove the whole of the posterior vaginal wall and the division of the vagina through the posterior fornix and thus into the peritoneal cavity is dealt with by the perineal operator

This results in the lateral ligaments being dealt with at a later stage in the operation and a greater part of them being divided by the perineal operator than in male cases The uppermost portions however should be divided by the abdominal operator who should be fully aware of the exact course of the ureters

The colon is now prepared for division by carefully preserving the marginal vessels and dividing them at right angles to the bowel at a site which will allow 2 inches of viable bowel to project through the abdominal wall at the site selected for the colostomy The bowel is divided between small clamps such as those of Zachary Cope using proper aseptic care and the whole specimen passed through the perineum when the perineal dissection is completed

Colostomy

A circle of skin is excised at a point about 2 inches along the line from the anterior superior iliac spine to the umbilicus

Owing to the centrifugal traction of the surrounding skin the removal of a ½-inch circle will usually produce an adequate permanent orifice A stab incision is made through the muscle layers the external oblique fibres being divided transversely to avoid constriction of the bowel

During this procedure the lateral margin of the laparotomy wound is drawn

towards the midline by holding forceps so that correct positioning of the colostomy may be made

The lateral margin of the laparotomy wound is now elevated by passing a long forceps through the colostomy incision and the paracolic gutter exposed A purse-string suture of thread or silk is inserted from the lateral border of the *colostomy incision including* some muscle fibres and continued under the peritoneum of the paracolic gutter to the mesenteric border of the colon When tied the space to the outer side of the colostomy is obliterated, thus preventing small bowel obstruction through what would otherwise be a narrow foramen

The proximal clamped colon is now passed through the colostomy incision Pelvic haemostasis is completed and it is often advisable at this stage temporarily to reduce the Trendelenburg angle to a level position so that any open veins on the lateral pelvic walls *may bleed and their presence be detected*

The remaining peritoneum on the lateral pelvic walls and iliac fossa is gently mobilized with the fingers and the peritoneal pelvic floor closed with greater ease than in an abdomino perineal excision since the pelvis is empty

A No 0 Chromic catgut is employed using an invaginating continuous Lembert stitch to diminish the chance of adhesion formation

The main pedicle should be covered and the suture continued laterally between the free edge of the divided mesocolon and the peritoneum of the left iliac fossa to the point of exit of the colon The abdomen is closed without drainage and the wound sealed with Whitehead s varnish and a waterproof top dressing

If the proximal colon is loaded with faecal material early and often violent bowel actions may occur and it is wiser to tie a Paul s tube into the protruding colon and trim the colostomy if necessary at a later stage

When the bowel is relatively empty the colon may be trimmed at the time to leave 1 inch projecting above the skin surface The lumen of the bowel *should* be carefully swabbed with 1–500 perchloride of mercury to minimize the risk of cancer cell implantation and the edges of all the coats of the colon then sutured to the surrounding skin No 1 chromic catgut sutures ½ inch apart are used and this produces a very satisfactory stoma with no tendency to skin stenosis

Perineal Dissection

The anus is closed with a subcutaneous purse string suture of strong silk to prevent soiling and as an additional precaution a small gauze swab may be tucked into the anus and rectum *The dissection is not commenced* until the abdominal surgeon has completed the exploration and decided that a combined excision is the correct procedure

The principles underlying the perineal dissection are those of an encircling movement The most difficult and intricate part of the *dissection is the* anterior portion and for this reason the posterior and lateral aspects of the rectum are dealt with first thus giving unhindered access to the anterior attachments

Apart from the initial skin incision and the removal of the coccyx the dis

section is carried out with straight blunt nosed scissors of varying lengths A transverse incision 2 inches in length is made in front of the anus and midway between it and the bulb of the urethra Lateral incisions are now made from its extremities and these extend backwards to meet over the sacro coccygeal articulation These incisions are deepened through the peri anal fascia to expose the lobulated ischio rectal fat and posteriorly the coccyx is exposed

The coccyx is now flexed to open up a coccygeal joint and the point of a scalpel inserted The distal portion of the coccyx is removed care being taken to keep the knife close to the superior surface of the bone to avoid damaging the rectum The middle sacral vessels may require ligation or fulgurization by diathermy at this stage

Removal of a portion of the coccyx usually facilitates the dissection and improves the access of drainage of the perineal cavity post operatively

Small lateral incisions are now made on either side of the coccyx through the fibrous attachment of the coccygeus muscle and a finger is inserted on each side in a forward and outward direction to separate the ileo coccygeus muscles from the underlying rectal fascia of Waldeyer As the finger passes forwards on the superior surface of the ileo coccygeus a gap will be found between the medial border of this muscle and the lateral aspect of the pubo coccygeus which lies in a different plane and covers the rectum With the finger still in this position to protect the rectum all the overlying structures (the ileo coccygeus muscle the ischio rectal fossa fat the inferior haemorrhoidal vessels and nerves) are divided well out on the lateral pelvic walls The vessels will require ligation

A self retaining perineal retractor (such as the St Mark s Hospital pattern) is now placed in position and by elevating the freed posterior portion of the rectum the fascia of Waldeyer will now be seen posteriorly extending from the bony and ligamentous pelvic outlet to the region of the ano rectal junction This fascia is firmly attached to the periosteum of the sacrum and must on no account be stripped up but should be divided with a semicircular incision at the pelvic bony outlet

The mesorectum (yellow fat enclosed in visceral pelvic fascia) will then be seen and this can now be safely separated by the hand from the hollow of the sacrum as far upwards as the promontory The hand is also swept from side to side to free the areolar attachments of the ampulla of the rectum from the postero lateral walls of the pelvis Both operators meet in this plane

Traction is now made on the isolated skin in front of the anus and by transverse incisions on either side the wound is deepened to expose the superficial and then the deep transverse perineal muscles The plane of dissection must be behind these muscles in order to avoid any injury to the urethra and when the deep transverse perineal muscles are completely exposed by dividing the decussating fibres of the deep external sphincter in the midline the whitish longitudinal fibres of the anterior rectal wall will immediately be seen

The broad fleshy straplike fibres of the pubo coccygeus muscles will now be seen on either side enveloping the lateral aspects of the rectum prostate or vagina as they pass forwards to their pubic attachments

A finger is now inserted above the superior borders of these muscles

separating them from the lateral aspects of the mesorectum whilst they are being divided as far forwards as possible on either side

The lateral aspects of the prostate can now be easily felt and the plane of the posterior aspect of the gland determined

The thick inferior borders of the pubo coccygei (pubo rectalis) together with longitudinal muscle fibres passing from the anterior rectal wall to the apex of the prostate and membranous urethra (recto urethralis muscle) still hold the ano rectal junction forwards in the middle line

This barrier is separated into two bundles by inserting a pair of artery forceps in the middle line towards the already located apex of the prostate the forceps must be parallel to the posterior plane of the gland to avoid injury to the urethra On gently opening the forceps the pubo-rectalis muscles will be identified on either side and thus separated

The separated muscle bundles are now divided in turn and the prostatic capsule exposed

Occasionally a thin layer of longitudinal muscle fibres obscures the capsule and requires separate division to avoid injury to the rectum and expose the true plane of cleavage

The prostate and rectum can now be readily separated by blunt dissection with the fingers but on either side stout and vascular visceral layers of pelvic fascia still hold the rectum to sides of the prostate and require division

The two surgeons will now have met anteriorly The anterior and posterior aspects of the rectum are now completely isolated and all that remains to be done is the division of the stout lower portions of the lateral ligaments The bowel is alternatively displaced to opposite sides and the stretched ligament divided close to the pelvic wall

The freed bowel is passed down from the abdomen and delivered through the perineum

Haemostasis is secured and to avoid reactionary haemorrhage the skin is not sutured until the blood pressure is within reasonable normal limits

In cases with bulky tumours where damage to the pelvic venous plexi may have occurred it is advisable to reduce the Trendelenburg tilt in order to detect and cope with bleeding from open veins The perineal skin is sutured with everting mattress stitches a corrugated rubber drain being inserted through the centre of the wound

When the peritoneal pelvic floor is high and thin a rubber bag lightly packed with gauze should be inserted into the pelvic cavity to give temporary support for the first three post operative days

In the female the dissection is similar but when the growth is adjacent or in apposition to the vagina the whole of the posterior and lateral walls of the vagina should be removed with the rectum The edges of the remaining vaginal wall are oversewn with a continuous catgut suture to prevent bleeding from the cut vaginal veins No attempt at reconstructing the vagina is necessary The whole perineal skin incision is sutured to reform the vaginal orifice through which the pelvic cavity is drained with corrugated rubber

The synchronous operation has now a well established position in the sur

gery of rectal cancer and is becoming increasingly the method of choice In the average case there can be no difference between the results of the three established methods of rectal excision However, in the advanced cases bulky and adherent to the pelvis or to other organs this may often be the only method by which excision is possible and some good results can be obtained

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CHAPTER XVII

RESTORATIVE OPERATIONS FOR CARCINOMA OF THE RECTUM AND RECTO-SIGMOID

C NAUNTON MORGAN

OPERATIONS for removal of carcinoma of the rectum with restoration of continuity are not new in fact, sacral or perineal conservative procedures antedated excision of the rectum by over half a century These earlier attempts at restorative surgery, however often resulted in inadequate removal of the primary growth and its upward lymphatic spread so local recurrence was common Furthermore the high morbidity due to sepsis and complications such as the formation of faecal fistula and incontinence brought conservative operations into disfavour

The great advantage of restorative operations is, of course the avoidance of a colostomy Re assessment of the mode of spread of rectal cancer greater care in the avoidance of implantation of malignant cells at operation, the introduction of sulphonamides and antibiotics, and advances in pre and post operative care and in anaesthesia have in recent years combined to place certain restorative operations in carefully selected cases on a sound foundation

PATHOLOGY IN RELATION TO RESTORATIVE RESECTIONS

Some facts in the pathology of rectal cancer of special importance in relation to restorative resection will first be mentioned

As frequently pointed out elsewhere in this book the occurrence of lymphatic involvement depends to a great extent upon the histological grade of a rectal cancer and also upon the degree of local spread of the primary growth The possibility of extensive spread distally is of great importance in relation to restorative resections but it is now well established that downward spread either local or lymphatic is uncommon It was only found in 27 of 1 700 operation excision specimens examined at St Mark's Hospital between 1938 and 1952 The incidence of downward spread in specimens where the growth was of low or average grade malignancy was 0 9 per cent whereas the incidence in that of high grade of malignancy was 4 4 per cent Thus downward spread was nearly five times more common in the high grade carcinomas Venous spread is also much more likely to be found in high grade malignant growths and retrograde spread may occur in the rectal wall and mesorectum below the level of the primary tumour in such lesions

There is unfortunately no definite pathological data available regarding incidence of lateral spread along the pelvic fascia and the levator muscles Wood

and Wilkie (1933) and Sauer and Bacon (1951) have shown that lateral spread in the pelvic musculature and fascia is unusual when the neoplasm is situated above the level of the peritoneal pouch Furthermore, Gilchrist and David (1947) found that the incidence of local recurrence was 23 per cent when growths with lymphatic metastases were situated below the peritoneal reflection On the other hand the incidence of local recurrence for similar growths placed above this level was only 3 6 per cent Gilchrist (1959) states that growths below the peritoneal pouch may spread laterally whilst those situated above this level will as a rule only extend in this direction when there is extensive lymph node metastasis with lymphatic blockage or where the primary tumour shows marked local spread At St Mark s Hospital the corrected survival rate for cancer of the intraperitoneal rectum with lymph node metastasis shows that of every 100 patients 38 survive 5 years whereas below the peritoneal pouch only 30 survive for this period This represents a relative betterment in progress of about 26 per cent for intraperitoneal growths This fact does indicate the increased risk of lateral spread in cancer of the extraperitoneal portion of the rectum

The extraperitoneal portion of the rectum is intimately enveloped by the pelvic fascia and pubococcygeus portion of the levator ani muscles and for this reason radical removal of a growth in this situation can only be obtained by sacrifice not only of the pelvic fascia but also of the muscular pelvic floor in fact by combined excision Though the height of the pelvic peritoneal pouch is variable it does give some indication of the level at which the pelvic fascia (related to the superior surface of the levator ani muscles) commences to en sheath the pelvic viscera

Upward lymphatic spread is by far the most common pathway whatever the site of the growth The widest possible removal of the upward lymphatic field must therefore be carried out in all cases of carcinoma of the rectum and recto sigmoid

In view of these facts concerning the spread of rectal carcinoma it can be postulated that a satisfactory radical operation for carcinoma of the intra peritoneal rectum and recto sigmoid requires generous excision of the peri rectal tissues *en bloc* together with the ascending lymphatic drainage along the inferior mesenteric vessels towards the aorta It need not extend downward for more than 5 cm below the level of the lower border of the primary tumour

Possible Implantation of Malignant Cells

The possibility of the implantation of carcinoma was considered at St Mark s Hospital in 1936 when recurrence at the suture line following restorative resection was found in a specimen subsequently removed by combined excision The hazard of implantation of malignant cells at operation was confirmed by Lloyd Davies and myself when we investigated the results of our first series of restorative resections in 1950 and my personal recurrence rate was 3 in 14 for this series Later Goligher Dukes and Bussey (1951) produced evidence that transplantation of carcinoma cells accounts for about half the recurrences at or near the suture line following anterior resection Following this McGrew

Lawes and Warren Cole (1954) demonstrated the presence of carcinoma cells in the lumen of the colon in 42 per cent of proximal ends of resected bowel and 65 per cent in distal ends, at average distances of 21 and 10 cm respectively Meanwhile the possibility that disinfection' of the large intestine by means of locally acting sulphonamides and antibiotics might increase the chances of transplantation was suggested by experimental work in rabbits resulting in the transplantation of the Brown Pierce tumour into the colonic suture line (Vink 1954)

Since 1948 at St Mark s Hospital cleansing of the bowel lumen and also the pelvic cavity with 1 in 500 mercury perchloride has been carried out with a view to the destruction of free malignant cells Since the adoption of this pre caution local recurrences on the suture line which could be explained has only occurred in 2 cases in a personal series of 148 anterior resections In none of the cases in which this solution of mercury perchloride has been used has there been any evidence of mercurial poisoning Other solutions such as freshly made full strength normal Dakin s solution, clorpactin and other compounds have been used in America for the purpose of diminishing the likelihood of implanta tion of cancer cells

Following the work of Warren Cole and his associates (1952 1954 1956) on the use of nitrogen mustard as an adjunct to surgery thiotepa is being used in a few cases to try and prevent dissemination of cancer cells, but as yet it is too early to assess the value of these cytotoxic drugs The presence of malignant cells in veins and a marked increase in the number of malignant cells circulating in the inferior mesenteric vein following manipulation of the growth at operation has been demonstrated (Engell 1955) Roberts *et al* (1958) Turnbull (1958) This confirms the importance of ligature of the vascular pedicle before a neo plasm is handled Economou *et al* (1959) emphasize the fact that the use of cytotoxic drugs is still in the experimental stage

Selection of Patients for Restorative Operations

I Type of Operation

A satisfactory operation for restorative resection must fulfil two require ments

(*i*) The procedure must allow of normal defaecation and have a low mortality and morbidity

(*ii*) The same upward lymphatic field should be removed as by com bined excision The rectum and the mesorectum together with surrounding tissues must be excised *en bloc* with a minimum of 5 cm of rectum below the lower edge of the growth

Anterior resection fulfills these desiderata and is undoubtedly the restorative operation of choice Abdomino anal resection (Maunsell Weir) may be of value in a small group of cases either as a palliative operation or for the removal of a suitably sited villous or papillary adenoma Its use is limited since a long length of colon is necessary to allow the anastomosis to be performed outside the anus The functional result is also uncertain A temporary concomitant colostomy is

usually advisable Operations of the pull through type which interfere with the sensitive lining of the anal canal damage the internal sphincter or sacrifice the whole rectal ampulla do not result in satisfactory rectal continence in most cases and are thus generally unsatisfactory

2 Site of the Growth

The growth should be situated not less than 10 cm from the anal verge as measured by sigmoidoscopy At operation such tumours will usually be found to be above the pelvic peritoneal floor The sigmoidoscopic measurement *together* with the relation of the lesion to the peritoneal reflection provide the basis for assessment of site In general a growth which is easily felt with the finger is too low but one whose lower edge is just palpable is probably suitable for restorative surgery

3 Extent and Histology of the Growth

When local spread is extensive or if the growth is of a high grade of malignancy as proved by pre operative biopsy the chance of local recurrence in the region of the anastomosis is considerably increased It must be recalled that extension of growth in the bowel wall in veins and lymphatics is often bizarre and widespread in anaplastic tumours of a high grade of malignancy Under these circumstances combined excision is the most satisfactory procedure

4 Hepatic Secondaries

Even in the presence of irremovable hepatic metastases if the primary rectal carcinoma appears to be completely removable anterior resection is still the operation of choice provided there is no special risk of local recurrence

5 Build of the Patient

Operative difficulties in a fat patient with a short fat ladened mesentery and a small pelvis may make it impossible to carry out a radical restorative operation

6 Associated Pathological Conditions

Extensive diverticulitis ulcerative colitis or malignant infiltration of other pelvic organs are contra indications to restorative operations

Operative Technique

Pre operative Preparation

The patient is admitted to hospital at least five days before operation Clinical assessment with special attention to cardiac and renal function is made and sources of infection treated Investigations including blood chemistry blood count and X ray of the chest are carried out Secondary anaemia will need to be treated by blood transfusion and the haemoglobin percentage restored to 80 per cent (11 8 grms per cent) before operation is contemplated Prostatic ob-

struction may require attention and though operation upon the rectal growth must not be delayed by major prostatic surgery preliminary transurethral prostatectomy may be indicated In cases unsuitable for this procedure pre and post operative bladder drainage will be required The introduction of a tiny Riches s suprapubic catheter before the abdomen is closed has proved useful

Particular attention is paid to preparation of the bowel Phthalylsulphathiazole 2½ grammes 6 hourly (10 grammes in 24 hours) is given during the five pre operative days and in addition, full does of vitamin C, vitamin B complex and vitamin K A mild aperient is administered on three successive evenings but is omitted 48 hours before operation Daily enemata are given three days before operation followed by a final colonic lavage on the evening preceding operation It is undesirable to give an enema or rectal lavage on the operation day

Sometimes when a constricting carcinoma is present it is possible to pass a rubber catheter beyond the growth, guided by means of the finger or through a sigmoidoscope However if under these circumstances decompression is unsatisfactory it is advisable to perform a preliminary right transverse colostomy

General anaesthesia is usually employed since perfect relaxation can be obtained by the use of muscle relaxants An intravenous drip is started before the operation commences and the bladder completely emptied by means of a *Foley catheter*, *manual compression above the pubis being maintained* until the bladder is empty and the end of the catheter closed to prevent the introduction of air In the female the catheter is removed at this stage In the male a fine polythene Gibbon catheter is useful since it is more comfortable post operatively and does not cause urethritis It may be used to replace the larger urethral catheter at the conclusion of the operation

Operation

The patient is placed in the Trendelenburg lithotomy position This position is of great value when performing restorative resection for carcinoma of the rectum The scrotum and penis with the indwelling catheter, are strapped to the front of the right thigh the skin of the abdomen and perineum prepared and both operation fields isolated with sterile lithotomy leggings and towels

A long left paramedian incision is made extending *down to the pubis* the skin covered with waterproof towels and the abdomen opened The primary growth should not at once be examined but the liver is first palpated for secondaries *If there is any doubt as to the nature of a palpable nodule of the liver it* should be inspected This is easily accomplished by standing between the patient s abducted legs and using a long deep retractor The upper abdominal viscera are palpated and then special attention is paid to the colon The faecal content of the bowel is noted and the whole colon palpated for the presence of any other primary malignant or innocent tumour The transverse colon is delivered the omentum inspected and the length and mobility of this portion of the intestine and its mesocolon observed The aortic region is palpated *for lymphatic* deposits

In order to protect the abdominal wall from contamination by free malig

nant cells or organisms polythene or cellophane sheeting is draped from within the abdomen over the wound surfaces and retained in position by gauze packs It is only now that the primary growth is examined It must be palpated with the greatest gentleness and its site in relation to the peritoneal reflection and sacral promontory is noted and its size degree of extension, attachment to other organs and fixity ascertained The peritoneum in the vicinity of the growth is next inspected for any extension to the serosa All unnecessary manipulation should be avoided and the examining hand immediately washed in 1 in 500 mercury perchloride before proceeding further with the operation These precautions are necessary in order to prevent transplantation of any free malignant cells

In the male the lower end of the peritoneal incision is sutured to the abdominal wall and in the female the uterus is fixed anteriorly to the lower end of the abdominal incision by means of a suture passed under the round ligaments

The intestine is now excluded from the operation area with gauze packs The packs protrude through the abdominal incision and a triple bladed self retaining retractor inserted The packs and retractor will keep the protective polythene sheeting in position The sigmoid colon is now delivered held to the right by an assistant and the congenital peritoneal folds on the left side of its mesentery are divided The left side of the mobilized sigmoid mesentery is now incised and the incision carried downwards to the brim of the pelvis and upwards along the outer side of the descending colon towards the splenic flexure The left ureter is next sought and may easily be found as it lies under the peritoneum in the region of the inter sigmoid peritoneal recess or fossa A finger is passed gently upwards along the ureter towards the left kidney and the mesentery of the left colon pushed forwards away from it The colon is next held to the left and the right leaf of the mesosigmoid divided The incision is carried upwards along the right side of the aorta to the level of the duodenum The front of the lumbo-sacral vertebral prominence is identified and by blunt dissection the inferior mesenteric vessels are elevated from the sacral promontory by means of a finger passed under the vascular pedicle from the right side to the left By holding the vessels forward it is possible safely to divide the retro peritoneal tissues freeing the inferior mesenteric pedicle posteriorly This dissection is continued upwards across the common iliac vessels and aorta to the origin of the inferior mesenteric artery all tissue on the front of the great vessels being removed A Deaver s retractor is inserted at the upper end of the incision to retract the transverse part of the duodenum upwards since the origin of the inferior mesenteric artery often lies behind this portion of the intestine

The origin of the inferior mesenteric artery is surrounded by sympathetic nerve fibres which must be divided in order to identify the origin of the vessel The artery is then tied with No 25 linen thread leaving a small stump at its origin to hold the ligature safely A forceps is placed distally and the artery divided The inferior mesenteric vein is usually situated between ½ and 1 inch to the left of the origin of the inferior mesenteric artery at this level and the left colic artery as it passes upwards to the splenic flexure lies in close proximity The tissue between the inferior mesenteric artery and the vein is quite often tough being composed mainly of sympathetic nerve tissue This is divided outwards

and upwards until the vein is encountered The vein and the accompanying left colic artery are ligated as high as possible at the level of the duodenojejunal flexure The mobilized root of the sigmoid mesentery is now held forwards and the position of the marginal artery and the sigmoid vessels noted These vessels can be more readily located by reflecting light through the mesentery from the right side The mesentery of the left colon is now divided towards its mesenteric border, great care being taken to preserve the marginal artery of the left colon which must be identified The incision of the mesentery is now continued down wards parallel to the marginal artery but an adequate amount of mesentery should be retained to avoid damage to this vessel The sigmoid vessels which will next be encountered are carefully ligatured and divided When the first sigmoid artery divides within an inch of the mesenteric border of the colon its bifurcation should be preserved since it may form a part of the marginal artery When this vessel divides soon after its origin from the inferior mesenteric artery its branches may be sacrificed

The advantages and possible hazards of high ligation of the inferior mesen teric artery during operations for carcinoma of the distal colon and rectum have recently been discussed (Morgan and Griffiths 1959) In suitable cases it would seem as if the high ligation of the inferior mesenteric vessels would enable a more radical operation to be undertaken and so improve prognosis after surgical treatment

A piece of tape is tied around the sigmoid colon a convenient distance above the growth to trap free malignant cells in its lumen before mobilization of the primary tumour is commenced

The ligatured ends of the inferior mesenteric artery vein and left colic vessels are now covered by peritoneum using a continuous catgut suture This suture is continued downwards for a few inches and then left until a later stage (after the anastomosis has been performed) before it is completed

When the primary growth is situated at the recto sigmoid (promontory of the sacrum) isolation of the inferior mesenteric pedicle is commenced at a higher level over the front of the aorta to avoid manipulation of the growth Under these circumstances the right leaf of the sigmoid mesocolon is incised at the level of the abdominal aorta and the peritoneal incision extended upwards to the origin of the inferior mesenteric artery and not downwards towards the recto sigmoid region until the vascular pedicle has been tied High ligation of the inferior mesenteric artery should not be carried out in a fat patient since the marginal artery may be impossible to identify and is easily damaged This added procedure is also inadvisable in old people because the operation time is lengthened and it should not be carried out when there is arterial disease In such cases the inferior mesenteric pedicle is ligatured at the level of the aortic bifurcation

When ligature of the main vessels has been completed the peritoneal in cisions on either side of the sigmoid mesentery are continued downwards into the pelvis for at least 3 inches below the level of the inferior edge of the primary growth The retro rectal space immediately below the promontory of the sacrum is now opened with blunt nosed scissors and the rectum freed from the sacrum

with the fingers and finally the hand, downwards to the extent of the lateral peritoneal incisions Lateral movement of the hand and fingers will make the upper portions of the lateral ligaments of the rectum more prominent Further mobilization down to the pelvic floor may be necessary in order to mobilize the rectum sufficiently

The lateral peritoneal incisions are now joined by a transverse incision in front of the rectum This is placed just anterior to the bottom of the recto vesical pouch in the male across the bladder base but in the female it lies at the bottom of the pouch of Douglas The posterior or rectal edge of this transverse incision is grasped in long artery forceps and by exerting a little upward tension the anterior dissection may be performed more easily The vesicles or vagina are identified and the posterior layer of the fascia of Denonvillers which is attached to the rectum seen The dissection is kept in front of this fascial layer close to the vesicles or vagina and the line of cleavage found The prostate or vagina is dissected off the rectum with the fingers strands of tissue being divided with scissors Dissection of the distal rectum should only be carried downwards as far as it is necessary for subsequent anastomosis

The lateral ligaments are divided near the lateral pelvic walls for 2½–3 inches below the level of the lower border of the growth

When the growth is situated in the recto sigmoid or upper rectum it is now possible to secure the superior haemorrhoidal artery or its branches immediately behind the rectum 5 cm below the lower border of the growth Often however it may be found easier to divide and ligature these vessels at a later stage after division of the rectum

An exclusion clamp is now placed across the rectum 5 cm —*by measurement*—below the lower border of the growth A clamp with a detachable handle has been found most useful for this procedure The excluded rectal stump is now irrigated through the anus with 1 in 500 mercury perchloride by an assistant The lumen of the rectal stump is cleansed by passing a rectal tube through a proctoscope and using a douche can Finally the rectal stump is distended with fluid by blocking the exit of the proctoscope with gauze swabs and then thoroughly emptied The anal canal is gently dilated to three fingers and the rectum dried with gauze swabs

During the toilet of the excluded rectal stump the operation proceeds and the length of proximal colon sufficient to complete the anastomosis in the pelvis without any tension is estimated It may be found necessary to mobilize the whole left colon and splenic flexure by further division of the peritoneum on the outer side of the colon Occasionally the transverse colon will require to be mobilized This is achieved by dividing the gastro colic omentum and opening the lesser sac Mobilization of the splenic flexure is best approached both from the right side through the lesser sac and from the left by division of the phrenico-colic ligament Great care should be taken to preserve the bifurcation of the left colic artery in this region since the bifurcation is essential for the blood supply of the left colon from the middle colic branch of the superior mesenteric artery after the inferior mesenteric artery has been ligated at its origin The division of the left colic artery lies 1–2 inches from the bowel at the splenic flexure The

transverse colon is mobilized by division of its mesocolon as far as is necessary, the middle colic artery being preserved

It will be remembered that at the preliminary exploration of the abdomen the degree of mobility of the transverse colon was noted If the transverse mesocolon is extremely short, its division may not produce enough mobility of the colon to allow the transverse colon or the splenic flexure and left colon to be brought down into the pelvis

The marginal artery is now divided at right angles to the colon at or preferably slightly below the point chosen for its division

Gauze packs soaked in flavine (1 in 500) are placed into the wound to isolate the bowel about to be divided Two Parker Kerr clamps are placed at right angles across the colon which is divided between them The divided ends are carefully swabbed and covering caps slipped over the divided ends Meanwhile the rectal toilet will have been completed and the rectum is now ready to be divided *below* the exclusion clamp Early in division of the rectum a lateral branch of the middle or superior haemorrhoidal arteries may have to be secured When the right corner of the rectal stump is divided a guide suture of white linen thread is inserted and further division of the bowel continued and the specimen removed Another guide suture is placed on the left corner of the divided rectum Bleeding from branches of the superior haemorrhoidal artery and vein will now be seen on the posterior and lateral aspects of the divided rectum and will require ligature A large abdominal swab soaked in 1 in 500 mercury perchloride is then placed in the pelvis over the divided rectum

The proximal end of the large intestine is now prepared The bowel is divided with a knife proximal to the Parker Kerr clamp, bleeding points carefully secured and a culture taken from the lumen The lumen of the gut is thoroughly cleansed for 3 or 4 inches with small swabs soaked in mercury perchloride 1 in 500 Finally the divided edges of the bowel to be anastomosed are also swabbed in the same solution

Before the anastomosis is commenced a final search for bleeding in the pelvis is made and haemostasis secured

A posterior layer of interrupted seromuscular sutures of 3/0 serum proof silk are now inserted between the colonic and rectal ends The first and middle seromuscular suture is placed in the colon on its left aspect, halfway between the muscular wall of the rectum in the middle posteriorly The musculature of the rectal stump retracts and care should be taken to secure good bites of this layer When the anastomosis has been completed, the proximal colon will thus have been rotated through at an angle of about 90 in relation to the rectal stump This rotation of the colon makes suturing simpler damage to the vessels less likely and places a completely peritoneal covered surface of the colon adjacent to the non peritonealized posterior aspect of the rectum

Six or eight seromuscular sutures are inserted and are all left untied, both ends being held in alternate small and large artery forceps to aid identification All the untied seromuscular sutures are now held upwards on their forceps and the colon is guided downwards to the rectal stump The sero-muscular

sutures are tied and cut with the exception of the centre suture and the two lateral guide sutures

A second posterior all layer continuous 2/0 chromic catgut suture with atraumic needles at either end is now inserted commencing at the middle of the anastomotic line When the first catgut stitch has been tied the centre black silk suture is cut On completion of the posterior portion of the anastomosis the corners are turned by means of a Connell stitch This type of stitch is continued to complete the anterior all coats layer Before the last Connell suture is drawn tight a soft latex or portex rectal tube (No 12) is passed downwards from the abdomen through the rectum and partly withdrawn through the anus by an assistant It is then pushed upwards into the colon through the anastomosis for 6–8 inches being guided by the abdominal operator and the catgut suture is then tied The rectal tube is fixed with strapping to the peri anal skin

An anterior layer of seromuscular silk sutures is now inserted and the linen guide sutures removed

The flavine packs are removed and all gloves changed The uncompleted peritoneal suture previously inserted to cover the ligatured inferior mesenteric vessels is continued downwards on the right side of the mesocolon and rectum and the bare area on the posterior aspect of the abdominal cavity and the right side of the pelvis reperitonealized Reperitonealization on the left side is often unnecessary since the bowel lies snuggly over the left pelvic brim

A soft latex rubber drain formed by placing ½ inch Paul s tubing within 2 inch Paul s tubing is placed in the pelvis behind the site of the anastomosis and brought out through a stab wound in the left iliac fossa This drain may be placed extraperitoneally if desired by stripping up the peritoneum of the left iliac fossa and left side of the pelvis This manœuvre is unnecessary if such a soft pliable tube is used and the omentum be brought down to more or less extraperitonealize it from the general peritoneal cavity The omentum is placed over the anastomosis and if possible between it and the vagina in the female

The abdomen is then closed in layers interrupted figure of eight wire being used for the anterior rectus sheath

A concomitant colostomy is rarely necessary but if the proximal colon is unduly loaded or there be any doubt about the security of the anastomosis this is established in the transverse colon near the hepatic flexure through a separate incision high on the right side of the abdomen

A simple colostomy using a glass rod is all that is necessary but care should be taken during its insertion not to injure the left branch of the middle colic artery The colostomy is opened at the conclusion of the operation and the edges of the colon sutured to the skin

When on rare occasions an abdomino anal resection has been performed a colostomy is a necessary adjunct

Post operative Treatment

The patient is nursed in the recumbent position for the first few hours and then gradually placed in a semi Fowler position

Penicillin 1 mega unit and 3 grammes of sulphamethizine soluble—1

gramme 8 hourly are given intramuscularly in 24 hours The soft rectal tube is moved after 12–18 hours and then should be slowly withdrawn at 12 hourly intervals

The abdominal drain is left untouched for 3 days and is then gradually removed by the sixth–seventh day The established post operative treatment for a major abdominal operation is carried out and fluids by mouth withheld until there is evidence of returning gastro intestinal movement When this has occurred a glycerine suppository may be inserted into the rectum If it is necessary to pass a rectal tube it is wise to pass only a short measured length to avoid damage to the anastomosis Very occasionally it may be necessary to pass a soft rectal tube through the anastomosis guided with a finger but this should not be attempted within 7 days of the operation

Continuous bladder drainage by urethral catheter in the male is continued for a few days and in a female a catheter is passed every 6 or 8 hours Normal urinary function returns between the second and fourth day

As soon as a patient has had a bowel action liquid faeces should be avoided and a bulk forming aperient (Normacol) is given in order to produce a firm stool

The patient may pass small and frequent stools for some months but when the anastomosis is soundly healed, the frequency diminishes to once or twice a day

Careful follow up is essential, not only to inspect the anastomosis and to permit early diagnosis of recurrence, but to anticipate the development of another primary tumour though both sequelae are uncommon The patient is seen every 3 months for the first year and thereafter at 6–12 months intervals

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CHAPTER XVIII

LOCAL EXCISION OF RECTAL CANCER AND TREATMENT OF MALIGNANT POLYPS

H E LOCKHART-MUMMERY

CARCINOMA ARISING IN RECTAL POLYPS

ONE of the most difficult problems that may face surgeons and pathologists interested in rectal disease is that of the proper treatment of patients in whom carcinoma has been found on microscopic examination of an apparently benign rectal polyp

Adenomatous polyps and papillary adenomas are both fairly common tumours of the rectum and malignant change may occur in time in both these benign tumours if they are not removed What course should a surgeon adopt if having removed such a tumour from the rectum which he believed to be benign the pathologist reports carcinoma? Should he rely on his local excision or should he advise a radical operation perhaps involving excision of the rectum and permanent colostomy? This difficulty would be easier to resolve if he could be sure that local recurrence in the bowel will would precede metastasis, but the fear of the latter occurrence may well influence him to advise radical surgery This problem has been a source of difficulty to rectal surgeons for many years and several divergent views on its solution are to be found in the literature This chapter will attempt to give a reasonable scheme for dealing with the problem when it arises based both on published views and on experience at St Mark s Hospital

Pathological Considerations

1 When should an epithelial tumour of the bowel be regarded as becoming malignant? Pathologists differ in their answer to this question some regarding changes in cellular structure and staining as indicating carcinoma others demanding stricter criteria, hence classifications such as adenoma with atypism carcinoma *in situ* and intramucosal carcinoma are used and cellular changes of this nature are regarded by some pathologists as definitely malignant Such cases should not be regarded as malignant both because there is no certain evidence that these changes always progress to invasive cancer and because pathologists may disagree on the identification of such cellular changes We have only regarded those cases as cancer which show invasion through the muscularis mucosae the criteria adopted also by Grinnell and Lane (1958) in reporting a large series Sometimes acini may be seen in the pedicle of a polyp merely as a result of a section which has happened to pass

through the depths of normal glands This artefact seldom leads to error and the absence of stromal reaction to the acini helps to differentiate them from invasive carcinoma (Starr 1958)

That such criteria are not too strict and hence a hazard to patients is borne out by our experience at St Mark s Hospital and by that of others (Fisher and Turnbull 1952) in that neither metastasis nor recurrence has followed the removal of an *in situ* or intramucosal carcinoma Local excision in such cases is entirely adequate for their cure as in the case of benign tumours

2 Carcinoma in a polyp may be found to be only just invading the stroma at the tip of the polyp or may be found to be invading deeply towards the base or may be found in lymphatics or veins (Figs 71 and 72) The extent of invasion is often the most important single factor determining further treatment and must be assessed as carefully as possible and several sections through the length of the polyp may need to be cut in order to do this Our experience has shown that both local recurrence and metastasis are most unusual when the carcinoma is confined to the tip (though we believe that it can occur in a tumour of high malignancy) Grinnell and Lane (1958) report no case of metastasis in their series unless invasion had taken place to the level of the base of the pedicle within a few millimetres of the muscle coat

3 It has been our practice when studying sections with the microscope to try to assess the degree of cellular differentiation of carcinomas and to classify them as of low average or high grade malignancy accordingly (see Figs 25–27 p 61) Such a classification may be difficult in those cases in which the entire focus of cancer in a polyp is still only very small but it should be made if possible because our experience has shown that the chances of recurrence or metastasis are directly related to the grade of malignancy as judged from the histology of the tumour In a series previously reported (Lockhart Mummery and Dukes 1952) we found that recurrence was uncommon in tumours reported as of low grade malignancy and that if it occurred it was as a local recurrence in the bowel wall unaccompanied by metastasis Tumours classed histologically as of high grade malignancy on the other hand were found to metastasize early sometimes without local recurrence and even when the tumour did not appear to be invading deeply into the stroma of the polyp Tumours reported as being of intermediate or average malignancy behaved rather less predictably with recurrence or metastasis only in certain cases

It follows from the above that the pathologist should have the greatest possible amount of tissue on which to base his observations A biopsy fragment removed from a polyp is usually inadequate for full diagnosis and may lead to an erroneous conclusion The entire polyp or papillary adenoma should be removed so that the whole tumour and its pedicle can be studied if necessary in many sections Close liaison between surgeon and pathologist is highly desirable whenever the section indicates that further surgical treatment may be needed

Treatment

In deciding what further treatment if any is needed for a patient with



FIG 71

Section through an adenomatous polyp showing carcinomatous change at an early invasive stage The pedicle is free from growth and removal appears complete

malignant change in a benign rectal tumour the main factors which will influence the surgeon s decision will be the pathologist s report as to the depth of invasion and the histological grade of malignancy But the surgeon will also need to take account of other clinical factors For instance the age and fitness

of the patient must be considered as in certain old or sick patients the risk of a major operation may exceed that of recurrence or metastasis Another factor which will weigh with most surgeons will be the actual site of the tumour in the rectum, if radical surgery would mean excision of the rectum and permanent colostomy, surgeons would be reluctant to advise it unless the risk of recurrence and metastasis was regarded as great whereas if the tumour had been in the upper third of the rectum and a restorative resection were possible radical surgery on those lines could more confidently be advised A further factor to be considered would be the patient s ability and willingness to co operate in future



Fig 72

A broad based polyp showing carcinomatous change which is invading deeply into the stroma of the polyp The carcinoma is of high grade malignancy

follow up only if good co operation by the patient could be assured would a conservative policy be justified in some cases

Every case therefore must be carefully assessed and the decision made according to the many factors already discussed Our experience at St Mark s has been that a conservative policy is safe and entirely justified in most cases and the following scheme is offered as a guide to treatment

If the Carcinoma is of Low grade Malignancy

Local excision alone is adequate treatment certainly so if the cancer is con fined to the tip of the polyp If invasion is more extensive into the stroma recur

rence is still unlikely and metastasis in the absence of obvious local recurrence does not occur Radical surgery is not necessary if removal of the polyp is complete

If the Carcinoma is of High-grade Malignancy

Metastasis is early and may have already occurred Radical surgery is advisable in every case

If the Carcinoma is of Average-grade Malignancy

If several sections through the polyp confirm that the cancer is confined to the tip then radical surgery is not required Metastases are not likely to have already occurred and a local recurrence is improbable The importance of careful and repeated follow up examination for years after should be impressed on the patient

If the cancer is invading more deeply to the stroma of the polyp and particularly if it has spread to near the base, then it is safer to advise radical surgery because we know that such tumours may metastasize in glands A conservative policy with very careful clinical follow up may be justified in patients who are considered poor operative risks

It is in such cases with cancers of average grade malignancy invading into the stroma that a decision may be so difficult in any individual case, here the level of the tumour may influence the decision A decision to advise radical surgery is easier to make in patients in whom a restorative resection would be technically possible Patients might be prepared to take a slight risk of possible recurrence if excision of the rectum and permanent colostomy were the alternative There is, moreover a further factor which reduces that risk for a local recurrence can usually be *felt* before it can be seen by a sigmoidoscope so that if the site of the original malignant polyp had been within reach of the finger then very early diagnosis of any recurrence that did occur would be likely if the follow up were frequent and careful so that treatment could be undertaken at an early stage Most recurrences occur within two years of the original excision (McLanahan, Grove and Kieffer 1949) but we have experience of recurrence occurring after five years

If the pathologist is unable to express an opinion on the histological grade due to insufficiency of tissue then the depth of invasion must be the main factor in making a decision If there is any suspicion that a carcinoma might be of *high grade malignancy or if it is deeply invading* then radical surgery is the safer course In other cases a watchful attitude, anyway for tumours in the lower rectum is reasonable and justified

In our experience the rather conservative policy outlined above has justified itself by results but careful observation and follow up is important Apart from the risk of recurrence or metastasis from the original tumour all writers about polypoid tumours of the bowel emphasize that people who have had a polyp removed have an above average tendency to form further polyps in the rectum and colon which in their turn may become malignant Hence periodic

examination by finger and sigmoidoscope is advisable, and an X ray examination of the colon should be done at the time of the original treatment and again later if any symptoms or signs arise to suggest a further polyp in the bowel

Local Excisions of Rectal Cancer

The accepted and correct treatment for carcinoma of the rectum is a radical operation to remove the part of the bowel containing the tumour plus the associated lymphatic field Yet there may be occasions, such as when the risk of a major operation is considerable when the possibilities of a lesser course must be earnestly considered Earlier in this chapter certain types of very early lesion have been discussed in which local excision is considered adequate treatment It is less easy to justify any purely local operation as the treatment for a lesion in the rectum which is clinically as well as histologically malignant, but every surgeon will be anxious to avoid an excision of the rectum and permanent colostomy in very small and early growths and local excision for such lesions may be reasonable if certain criteria are fulfilled First the lesion itself must be small (i e not more than ½ inch or so in diameter) and clinically early in that it must feel mobile on the underlying muscular wall Second it should be in the lower rectum within reach of the finger Third it should preferably be of low-grade malignancy as judged by biopsy In my opinion it is only in such circumstances that local excision should even be considered in preference to an orthodox cancer operation for a clinical carcinoma of the rectum Exceptions may be made in the case of elderly or unfit patients in whom rather more advanced or less well differentiated tumours might be considered for local treatment only but the risks of recurrence and metastasis are then increased and must be weighed against those of the operation in that particular patient In patients fit for major surgery any growth more than 10 cms from the anal verge can be treated by restorative resection in patients of average build and the question of local excision should rarely arise

Local treatment by diathermy of advanced rectal cancers as a palliative measure is a different problem altogether which has already been discussed in Chapter XIII

Methods of Local Excision

1 *Delivery Outside Anus Excision and Suture*

This is the method to use whenever possible The anus is fully dilated the tumour is grasped (sponge forceps are usually satisfactory for this purpose) and pulled as far down towards and out of the anus as possible It may then be excised with diathermy or with scissors taking a good margin of surrounding normal mucosa round the visible and palpable base of the tumour The excision should include some of the muscle coat deep to the tumour and removal of the whole thickness of rectal wall is sometimes possible The excision should start above the tumour and as the removal proceeds interrupted catgut sutures are

inserted to approximate the bowel wall and to control bleeding When the whole tumour has been removed and the wall sutured, the stitches are cut short and the wound retracts inside the anus, a finger should then be passed to make sure that the lumen is not unduly narrowed

2 *Diathermy Snare*

The main value of the diathermy snare is in the removal of pedunculated tumours but it is also possible to remove small protuberant tumours by this method It is difficult, however, to gauge the depth of removal, which if too deep may perforate the bowel and if too shallow may not remove all the tumour After removal of a tumour by the diathermy snare the surface of the resulting wound may be gently touched with the coagulating diathermy button so as to destroy any tumour cells that may have been left

3 *Posterior Approach*

Tumours on the posterior wall of the lower rectum may be approached by exposing the rectum from behind With the patient prone or in a lateral position an incision is made posterior to the anus and the coccyx is removed The posterior rectal wall with surrounding fat and vessels, is then exposed by dividing the fascia of Waldeyer The tumour can then be felt through the wall and an incision made to encircle it and to remove an oval area of rectal wall including the tumour The rectal wall is then carefully sutured in two layers and the wound closed with drainage to the pre sacral space

There are two dangers in this operation One is that a fistula may follow if the suture line leaks though careful preparation of the bowel and meticulous technique will minimize this risk The other is that of implantation of malignant cells in the wound or rectro rectal tissues which though slight is not negligible This risk can be minimized by careful irrigation of the wound before closure with a solution lethal to free malignant cells

In our experience the first method is the most satisfactory when it is practicable as it permits reasonable clearance around the tumour and has been found to be a method causing very few complications and little disturbance or pain to the patient However it must be emphasized again that the occasions on which local excision should be preferred to a radical operation in the treatment of rectal cancer are few and unless cases for this limited procedure are carefully selected bad results are to be expected After any form of local excision careful examination must be carried out at frequent intervals so that if recurrence does occur radical operation may be undertaken without delay

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CHAPTER XIX

RADIOTHERAPY OF CARCINOMA OF THE RECTUM

I G Williams

RADIOTHERAPY of cancer of the rectum with X rays *generated at 250 kV* has been a complete failure No consistent reports have been published of any benefit from such therapy, and the method has been abandoned The differential effect between the neoplastic and normal tissues is small and could not *be exploited to the full with 250 kV X rays* because of the difficulty of delivering an adequate, uniform tumour dose This is so for three main reasons (1) the depth and bulk of the lesion, (2) the small percentage depth dose at the lesion and (3) the shielding effect of the bones of the pelvis through which the beam has to pass It is of course irrational to expect control of bulky adenocarcinoma with doses lower than one would give to control the rather more sensitive squamous celled carcinoma With 250 kV X rays it is impossible to deliver higher doses with safety because the normal tissues around would have to be raised to similar dose levels with damaging effect Radiotherapy is fundamentally an art and, based on experience, various factors can be adjusted to increase the effect on tumour cells and minimize the effect on normal tissues The most important factor in cancer cure is the delivery of an adequate tumour dose It has been possible in small superficial lesions by contact therapy or by the implantation of radioactive sources to raise the tumour dose to a high level and in this selected group of rectal cancers, a moderate success has been obtained

With the introduction of supervoltage X ray units and radioactive isotope beam thereapy it is now possible to deliver adequate doses to the whole lesion by external irradiation As the voltage is increased the percentage depth dose increases and there is less differential absorption of the rays in tissues of different density so that with high voltage radiations, it is possible to raise a specified volume of tissue to a much higher dose level than the normal tissues receive

When the one million volt X ray machine was installed at St Bartholomew s Hospital in 1936 it was thought reasonable to submit patients with cancer of the rectum to radiotherapy as a planned experiment

An important factor in considering radiotherapy in the treatment of any cancer is the natural history of the tumour and how this may assist us in gaining the maximum benefit from our treatment In advanced cases of cancer of the lung for example the expectation of life is so short that it seems unjustified to subject the patient to a long course of treatment for palliative reasons alone The extent of the primary lesion and the routes and speed of spread of metastases do much to determine the effort which should be put into treatment Like

surgery radiotherapy is a local form of treatment, and hope of cure is governed by the extent of tumour spread Cancer of the rectum usually grows slowly It has been estimated that it may take a year to encircle the circumference of the bowel During this time the extent of extra rectal spread may still be limited, while this gives the surgeon great opportunities it also offers scope for radio therapy The symptoms of cancer of the rectum are due to the local tumour mass obstruction, mucous discharge, bleeding and tenesmus Relief from these is worthwhile, even though the patient may still have residual tumour left behind after treatment because he may live for months or even years, quite long enough to benefit from such relief and to lead a fairly normal life This is sometimes dramatically evident even in the presence of distant metastases hepatic, pul monary or osseous Shrinkage of the tumour mass in the rectum restores normal *bowel function and may avoid the need for a colostomy It is surprising how* normal bowel function can sometimes be even with a hard fibrotic tumour residue in or around the bowel wall

The Indications for Radiotherapy

Primary Rectal Cancer (*Curative Therapy*)

1 As a primary method of treatment in early or localized cancer radio therapy has not yet offered a serious alternative to surgery Whilst it would be pleasing regularly to destroy rectal cancer leaving the patient anatomically nor mal without the burden of a colostomy (and this has been achieved) its effects are as yet too unpredictable and our knowledge of each particular tumour s response too uncertain to rely on this method in the face of the excellent results achieved by surgery It can however be used in that class of patient who on grounds of poor general health *is considered unsuitable for surgery Where the* aim is cure of the patient of this disease surgery holds pride of place

2 Whilst the majority of rectal cancers are well differentiated and slow growing anaplastic tumours of a high grade of malignancy do occur especially in younger people In such in spite of the formidable extent of the surgery the disease may be microscopically spread beyond the scope of the excision and rapid local or pelvic recurrences occur after operation It would be rational to treat this class of patient with radiotherapy for they are biologically inoperable

3 Post operative radiotherapy should be considered in patients with ana-plastic tumours or with known residual disease after operation The objective here is to destroy the remaining cancer and so anticipate and prevent the development of local recurrence or metastases The indications however, must be quite clear and definite for to add a long course of irradiation to the surgical treatment is a heavy burden for the patient

Palliative Radiotherapy

The slow rate of growth of many rectal cancers in the sites of distant metas tases (even the liver) as well as locally in the pelvis is borne in mind by the sur geon who will often operate when the disease is locally advanced to rid the

patient of the distressing symptoms due to the primary tumour Growing experience however suggests that greater caution and care should be exercised in selecting patients with advanced disease for palliative excision of the rectum In some such patients cutting through neoplastic tissues results in local recurrence in the pelvis which soon implicates the pelvic nerve plexus, resulting in pain either sciatic or perineal Here the slow rate of growth may be detrimental for this pain is difficult to control and the patient s life may be prolonged in misery and exhaustion Radiotherapy can often offer this class of patient the same certainty of relief from the symptoms due to the primary growth It may avoid a colostomy, and can now do this without risk of severe symptoms or morbidity For these patients it should be seriously considered as an alternative to surgery

Technique of Radiotherapy

1 *Radium (or Other Radioactive Isotope) Implantation*

There is still a place for radium implantation It is reserved for those patients who are unfit for major surgery and who have a low tumour of limited extent which can be adequately covered by a single plane implant The patient is prepared as for other operations on the rectum and under general anaesthesia the needles are inserted beneath the tumour in a pattern according to the Paterson Parker rules In order to avoid crossing the ends differentially loaded needles are used to deliver a dose of 6 000 r in one week at 1 cm depth Intra cavitary rectal applicators are no longer used

2 *X-ray Therapy*

X rays generated at one million volts or more or gamma rays from radioactive isotope sources such as Cobalt 60 in telecurie units are essential in order to deliver an adequate tumour dose Treatment time extends over 6 to 8 weeks and a cylinder of tissue of average width of 12 cm and extending from the anal margin upwards for 18 or 20 cm is raised to a dose of 6,000 r through fixed fields or by rotation of the source Because of the low radiosensitivity of adenocarcinoma of the rectum and the relatively high sensitivity of the normal tissues dosage levels are critical Even when palliation only is the aim, high dosage with great care in treatment planning is essential This also applies to recurrent disease after operation when it is confined to the pelvis Bone metastases massive perineal or pelvic recurrences can be treated by simpler field arrangements in shorter time this is done when the prospect of life is short and the aim of therapy is merely to make the patient s few remaining days more comfortable In patients with disease confined to a treatable volume of tissue (in the pelvis) whose expectation of life may be two or three years the same care in treatment planning is as essential as it is when cure is the aim By such means the patient s life can be made more comfortable sometimes for a surprisingly long period of time even with advanced or recurrent disease

Reactions to Supervoltage Radiotherapy

1 *Immediate*

General reactions consiting of nausea or vomiting lassitude and depression have been slight Daily treatment sessions are short the total duration long In the management of these patients good food, sunlight and fresh air, together with sympathetic care and occupation for their hands and minds in the long intervals between treatments are important This treatment is tedious which contributes to the general reaction as much as the specific effects of irradiation

The effects on the blood are slight and apart from patients who have a normal low white cell count have not led to any interruption in treatment Anaemia due to bleeding and infection may need correction

Local reactions have been fairly severe In nearly half the patients treat ment was not straightforward and had to be interrupted delayed or modified At a dose level of about 2 000 r at the end of the second week or during the third week frequency of micturition cystitis or diarrhoea may develop These respond to simple measures and in no instance constitute a hazard to the patient

At the end of treatment skin reactions have developed in some patients Erythema with moist desquamation of the perineal and vulval skin and in the groins has been usual At one million volts in order to achieve high tumour doses it is necessary to push the treatment to the limits of skin and mucosal tolerance Skin reactions will not occur to the same degree with higher voltages so that treatment should be much easier for these patients though they may of course get bladder and bowel reactions

2 *Late Reactions*

Skin which has developed an acute erythema becomes thin pigmented hairless and dry telangiectasis may follow Such consequences are variable and not serious Endarteritis of deeper and larger vessels may however result in subcutaneous fibrosis with the formation of avascular collagenous tissue liable to necrosis Recto vaginal and vesico rectal fistulae occured in 14 patients (6 per cent) chronic radiation necroses of skin and subcutaneous tissue occurred in 9 (4 per cent) It was difficult to determine whether fistulae in some patients were due to radiation necrosis or destruction of neoplasm in the recto vesical or recto vaginal septa or whether continuing tumour spread was responsible Normal tissues being devitalized by heavy irradiation have less healing power to repair a gap

A further complication is fibrosis in the bowel wall and the pararectal tissues affected by the neoplasm This may be of sufficient degree to obstruct the bowel and occurred in 32 patients (14 per cent) If colostomy has not been done for obstruction due to the neoplasm it may have to be done later for ob struction due to fibrosis The rectum may become a rigid tube embedded in stony hard fibrous tissue (probably also containing dormant cancer cells scat tered in avascular collagen) in some cases a localized stricture may form at the site of the neoplasm Stricture formation in normal bowel outside the neoplasm is uncommon

Results

In presenting these results it should be remembered that St Bartholomew's Hospital has had the only radiotherapy department treating patients for this disease with supervoltage irradiation until the last few years Moderate success resulted in the reference of patients in all stages of dissemination of the disease but sentiment together with lack of experience at first, often overruled clinical judgment in accepting patients for treatment Patients were referred mainly from St Mark's and St Bartholomew's Hospitals, where the standard of surgical skill in treating this disease is high, and where the resection rate of primary cancer of the rectum is of the order of 90 per cent These facts should be borne in mind when evaluating the results of radiotherapy presented here

Radiotherapy is a wide term implying the treatment of disease by a wide spectrum of varying wavelengths of radiations 1 MeV is a little too low voltage to exploit fully the physical advantage and differential effect between normal tissue reactions obtainable with supervoltage irradiation We still obtain severe skin and mucosal immediate reactions as well as late effects Better results with less morbidity may well be achieved with the still higher voltages now available Our results with 1 MeV X rays should be regarded as illustrating a step in the development of a method of treatment The control of symptoms due to the primary tumour is more important than survival figures in assessing the value of what has been done because a patient who is incurable by surgery on account of metastases is also incurable by radiotherapy The consequences of recurrence and the morbidity after palliative excision of the rectum in patients whose disease is anaplastic or far advanced are exceedingly distressing The important question to decide is whether, in the light of our experience, such patients should be referred more often for radiotherapy It is our opinion that this should be so and that the indications for palliative excision of the rectum should be critically reviewed

TABLE XVIII

Results 220 patients with Primary Cancer of the Rectum were Treated by Irradiation in the years 1939–55

Age distribution	
Age in years	*Cases*
20–29	5
30–39	12
40–49	31
50–59	54
60–69	61
70–79	46
80–89	11

Average age 60 years
Sex distribution Male 154 Female 66

These patients were classified into three broad groups based on a clinical assessment of the extent of the disease More accurate information from laparotomy was available in many

1 Early The growth involved the whole rectal wall but as far as could be ascertained did not extend beyond these limits—37 cases (17 per cent)

2 The growth involved neighbouring pelvic structures and was locally advanced—150 cases (68 per cent)

3 Distant metastases outside the pelvis were present—33 cases (15 per cent)

Eighty three per cent had advanced disease probably beyond the scope of curative treatment

Survival

Of the 220 patients 65 survived two years (29 per cent) 12 patients survived 5 years and over (5 5 per cent) 18 patients died from other causes within the 5 year period in many cases with control of symptoms due to their rectal cancer An 8 per cent of deaths from other causes is not high when considered in relation to the age groups and the fact that many of our patients were selected for this form of therapy because of their poor general condition

Relief of Symptoms due to the Primary Growth

Bleeding and mucous discharge are objective signs and assessment of their relief can be definite Pain and tenesmus are subjective and reliance in estimating effect must be placed on the patient s evidence

TABLE XIX

	Present	*Completely relieved*	*Partially relieved*	*No relief*
Bleeding	150	104 (76 %)	20 (13)	16 (11)
Mucous discharge	126	51 (41 %)	32 (25)	43 (34)
Tenemus	70	38 (54)	13 (18 5)	19 (27)
Pain	111	52 (47 %)	32 (29)	27 (25)

Rectal bleeding was relieved in the large majority of these patients whilst the other signs and symptoms were also relieved in a large number Colostomy was done in 122 patients but was not necessary in 98 In many this had been done by the surgeon at the time of a laparotomy Thus colostomy for obstruction did not appear essential nor was it required later in about half the patients treated

It is difficult to convey the measure of our meagre success statistically Three patients still survive for 20 16 and 13 years

Illustrative Cases

Female aged 41 Laparotomy, colostomy 1938 Adenocarcinoma of rectum fixed to sacrum with local glandular metastases 5 000 r to the whole pelvis in 39 days 1941 colostomy closed She has an irritable bladder due to telangiectasis and radiation effects on the bladder but is quite comfortable

Male aged 41 Carcinoma surrounding rectal wall and filling its lumen 5 800 r to the whole pelvis in 38 days At the time of treatment he was in severe pain and ill from repeated haemorrhages He was back at work in four months and has remained well and at work since

A general practitioner with proven liver metastases returned to his practice and lived for 18 months symptom free and without a colostomy

Another doctor lived 3 years before a rapid terminal illness occurred resulting from metastases Two patients both over 80 years of age lived 2 years without needing a colostomy, and died from heart failure free of rectal symptoms

Post-operative Radiotherapy

This has not been carried out as a planned programme A few patients have received immediate post operative radiotherapy because local conditions after operation were such that rapid recurrence was thought possible In these who were all unfavourable (some had glandular metastases above the point of ligature others bladder involvement by direct tumour spread) no appreciable benefit resulted from the radiotherapy

Removal of the Rectum after Radiotherapy

In 5 patients the rectum has been removed after radiotherapy Operation was done because (1) residual disease was present (2) symptoms recurred or (3) operation became technically possible Operation was not performed as a planned programme each case being individually considered One patient developed rapid local recurrences in the perineum and pelvis as well as generalized metastases and died within 3 months A woman aged 68 developed recurrent bleeding 12 months after treatment of a growth at the pelvi rectal junction Following a conservative excision the wounds never healed she developed a coccygeal necrosis faecal fistulae, and died from infection Histology revealed a small focus of adenocarcinoma embedded in dense fibrous tissue In the three other cases post operative convalescence proceeded normally, although healing of the wounds was slower than in non irradiated patients One patient has lived 5 years and is well and clinically free of disease

Pathological Findings

(Contributed by Dr A G Stansfeld)

In one of the 5 patients in whom excision of the rectum was carried out after a course of radiotherapy the total dose given was only 2 173 r and no piece had been taken for biopsy prior to treatment so that this case is *of little* value in assessing the results of therapy Each of the remaining 4 patients had a clinically inoperable adenocarcinoma of the rectum and each received a *total*

tumour dose of 6 000 r. Sufficient objective improvement took place after treatment in each of these four patients for a previously inoperable growth to be considered operable and excision of the rectum was therefore performed. The period elapsing between the conclusion of X ray therapy and operation was 6 weeks in two cases, 9 weeks in one and 12 months in the other.

In none of these cases had the tumour been completely destroyed by irradiation, though the effects of therapy were apparent in the reduced size and increased mobility of the growth at operation. In each of the 4 operation specimens there was obvious cicatrization at the site of the primary tumour and on microscopy small foci of viable adenocarcinoma cells were found enveloped in a mass of fibrous tissue which extended through the rectal wall and spread out into the peri rectal fat. There was evidence that the muscularis of the rectum had only been replaced by fibrous tissue where there had previously been carcinomatous invasion or infection consequent upon such invasion. In the patient where operation had been deferred for 12 months after irradiation limited mucosal regeneration had taken place over the cicatrix. In the others an ulcer persisted, the floor formed of necrotic granulation tissue sometimes containing small islands of carcinoma. Small arteries in the neighbourhood of the irradiated tumour showed varying degrees of obliterative endarteritis and hyalinization of their walls. Some were occluded by organized thrombus.

Only in the two most recently irradiated cases were traces of necrotic carcinoma cells to be seen in the scar tissue, but small pools of mucin or epithelial lined mucin filled cysts were found in 3 cases often at such a depth in the rectal wall that they could only have been derived from infiltrating carcinoma cells. Apart from such isolated epithelial remnants, the growth of which was clearly restricted by their environment of avascular fibrous tissue, the pattern and histological grading of the carcinoma did not seem to have been affected by irradiation. Viable areas of tumour tissue in the excised specimen were indistinguishable from the tumour in the initial biopsy in each of the 3 cases where sections were available for comparison.

Recurrent Cancer of the Rectum

One hundred and fifty five patients with recurrent disease after surgical treatment were referred for radiotherapy. The operations performed for the primary growth varied in their extent and there was little difference in time intervals in the various groups, the shortest being 3 months, the longest 6 years and the average about 1 year.

The commonest symptom of which these patients complained was pain — 140 patients. In 25 patients the pain was unassociated with any physical sign; in the remainder there was a mass, a bone metastasis or perineal nodules. Even in the absence of any sign persistent pain is almost always due to a recurrence, for subsequently the growth reveals itself as a tumour mass or bone metastasis. The pain may be the severe lancinating pain of nerve involvement, the deep seated ache of soft tissue infiltration or the boring pain of bone erosion. It may be felt in the lumbar region, the perineum or referred down the buttocks or legs. There may be a phantom rectal pain with tenesmus. If the site of origin

cannot be located by physical signs, such as a tumour mass accurate neuro logical examination is essential in order to determine the region to be irradiated

Apart from pain, other presenting *manifestations of metastases* were perineal nodules a tumour mass, enlarged lymph or involvement of the bladder or vagina

If full clinical and radiological examination revealed that the disease was confined to a treatable volume of tissue in an otherwise fit person an attempt was made to give radical therapy to high dosage (6,000 r in 6 weeks) In the remainder, palliative therapy of lower dose in shorter time was given The aim of treatment was to relieve symptoms but we hoped to prolong life in a few

Results

Out of 155 patients treated 10 are alive and 145 are dead

Alive 10	Dead 145
1–15 years	Died in 6 months— 60
1–12 years	12 months—101
2– 8 years	24 months—133
3– 5 years	1 lived 6 years
3– 3 years	1 lived 5 years
	2 lived 4 years

In those treated by radical therapy, the average survival was 16 8 months for palliative therapy 6 months in most of these symptoms were relieved in the treated zone for this period of time *Out of 140 patients whose main complaint* was pain 21 had no relief and 119 were benefited In 80 patients the relief was complete although it recurred in some with the advent of new metastases In 39 it was partially relieved the patient could sit or walk with greater ease but here again it returned when new or recurrent growth developed The radio sensitivity of adenocarcinoma has been demonstrated in a few cases with fun gating or ulcerating metastases which shrivel and regress, and perineal nodules which frequently disappear Our observations suggest that the mucoid or colloid *cancers appear to be the most radioresistant*

The patient who is alive 15 years after treatment was referred with a bleed ing growth fungating through his colostomy and a large mass in the left iliac fossa Less than 12 months previously he had had an abdominal perineal excision of the rectum for an adenocarcinoma A second transverse colostomy was done and the tumour treated radically He is alive and well with two colostomies, and in full active employment

Conclusions

It is important to remember that the foregoing is a record of what has been achieved in the treatment of patients with this neoplasm during an early phase in the development of supervoltage radiotherapy From the era of no effect with 250 kV X rays we have progressed to the phase of some effect with 1 MeV X-rays *With this modality we can expect* to achieve for suitable patients

1 A small long lasting survival rate (cure)
2 A reasonable chance of avoiding a colostomy
3 Valuable relief of symptoms due to the primary growth

Our experience during the past years and the improved apparatus now available together with our increased knowledge of the natural history of rectal cancer, and of radiobiology, should allow us to deliver the optimum physical characteristics of any quality of radiation we require and contribute to greater hope for the future The most important factor for any local method of treatment, however, will always be the extent of the anatomical spread of the disease at the time the patient comes for treatment

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SECTION SIX

POST-OPERATIVE CARE AND COMPLICATIONS

CHAPTER XX

POST-OPERATIVE CARE FOLLOWING OPERATIONS FOR RECTAL CANCER

HENRY R THOMPSON

THOROUGH pre operative assessment and preparation of the patient with a rectal cancer is the basis for successful post operative care and management

Many patients undergoing an excision of the rectum for carcinoma are in the age group with a high incidence of chronic bronchitis arterio sclerosis and coronary artery disease thus the post operative course may be complicated by disorders of the heart and lungs A physician called in to advise in the management of such complications is in a strong position if he has assessed the patient before operation and has a pre operative chest X ray and electrocardiogram to hand Similarly certain pre operative laboratory tests on the blood and urine should be made Although it is exceptional for such biochemical examinations to influence or modify operative treatment they are of value in the event of complications for comparison with post operative readings A blood group blood urea haemoglobin estimation and examination of the urine are minimum requirements

As a rule a patient should be admitted to hospital 5 days before operation During this period he is instructed in breathing and leg exercises and how to expectorate with the minimum of discomfort after operation Drugs are administered to sterilize the colon and its contents are cleared as far as possible by enemata The opportunity is taken to explain to the patient the nature of his operation and what will be required of him in the post operative period

A rectal cancer may be removed by a combined excision a restorative resection or a local excision Post operative care will be considered under each of these three headings

1 COMBINED EXCISION OF THE RECTUM

Post operative care commences with the transfer of the patient from the Trendelenburg position on the operating table to a more horizontal position in the ward bed During the closing stages of the operation anaesthesia can be allowed to lighten in order that spontaneous respiration may be re established by the time the operation is completed While the superficial layers of the abdominal wall are being sutured the operating table is gradually levelled from the Trendelenburg tilt careful watch being kept on the blood pressure After this change of position small pelvic veins may start to bleed and a close watch

must be kept on the perineal wound to ensure that such bleeding does not escape notice

Theatre Dressings

Three sets of dressings are required for the paramedian incision, the colostomy and the perineal wound Because of the proximity of the colostomy the paramedian wound should be sealed This can be done effectively by using Whitehead s varnish applied to superimposed strips of $\frac{1}{2}$ and 1 inch wide ribbon gauze laid along the length of the wound The clamp should not be removed from the colon to open the colostomy until the paramedian wound has been sealed The ribbon gauze and Whitehead s varnish are in turn covered with dry gauze and cotton wool The colostomy is covered with a piece of *tulle gras* and further dressed with gauze and cotton wool These dressings are kept in place by a many-tailed bandage with two perineal extensions attached to the lower posterior edge of the binder The perineal dressing, which should be relatively small is kept in place by a triangular (48 inch sides) bandage and further supported by the perineal bands from the abdominal binder

Tracheo-bronchial Toilet

The final step before moving the patient from the operating table is a tracheo bronchial toilet A child sized rectal tube (English catheter gauge 8) is passed down the endotracheal tube and mucus is aspirated from both main bronchi the trachea and pharynx also being cleared as the tubes are withdrawn Suction should be at a vacuum of at least 20 inches of mercury if the viscid mucus present in the bronchitic cases is to be removed Following removal of the endotracheal tube a Guedel airway is inserted into the oro pharynx Great care must be taken to maintain a clear airway for at this stage even a short period of anoxia can do great harm to a shocked patient or a patient recovering from shock

Return to the Ward

Where possible the patient should be lifted from the operating table direct into his warmed ward bed This avoids the double move from operating table to trolley and from trolley to bed If such a double move is necessary the trolley should be fitted with an adjustable ratchet so that a head-down position may be maintained and should carry an oxygen cylinder The blood pressure and pulse of the patient should be recorded immediately before he is lifted from the operating table and again on his arrival in the ward Sometimes especially in obese patients after a difficult operation a move can cause a sudden deterioration in the patient s condition and if it is apparent that this has happened before the patient is moved from the trolley to bed this move should be postponed until his condition improves

Recovery Room

When there has been considerable loss of blood during the operation and

the patient is manifestly shocked he should not be returned to the ward but kept in a recovery room adjacent to the theatre where both surgeon and anaesthetist can keep a careful watch on his condition

Immediate Ward Care

In the ward the foot of the bed should be raised on blocks, a satisfactory airway ensured and a macintosh and drawsheet placed under the perineal wound which is checked for bleeding One of the commonest causes of deterioration of the patient s condition in the immediate post operative period is reactionary venous or arterial haemorrhage from the perineal wound and in order that this may be expeditiously recognized the dressings on this wound should be small and a hand should be passed frequently between the perineal wound dressings and the bed to make sure that there is no excess bleeding It is usually necessary to augment or change the perineal dressings three times in the first 24 hours If however the bleeding from the perineal wound is persistent and associated with a rising pulse rate the surgeon should be notified immediately

After 6–12 hours, according to the patient s condition the bed is levelled and the patient gradually sat up Morphia will be required in the first 24–48 hours after operation

The Charts

The following charts must be kept—a routine morning and evening and 4-hourly pulse and temperature chart a daily fluid balance chart recording the daily intake and output of fluid and a weekly chart summarizing the daily totals During the first 24 hours an hourly pulse recording is made on the daily fluid balance chart and the blood pressure is recorded at regular intervals

Parenteral Administration of Fluids

An intravenous drip should be established in one of the forearm veins after induction of anaesthesia A canula rather than a sharp needle whose point can roughen the vein wall and predispose to thrombosis should be used It is secured in position directly in the line of the vein by strapping after shaving the hairs from the forearm Veins of the leg and ankle should only be used as a last resort Every care and attention to detail should be taken to see that the intravenous drip is efficiently set up Thrombophlebitis occurring in the veins used for intravenous drips is a painful and irritating complication for the patient and the repeated changing of unsatisfactory drips becomes a dreaded curse of the post operative period It must be stressed that the pain following the com plications of unsatisfactory intravenous drip therapy may be a far greater trial to the patient than the pain of the three operation wounds

In the average case one pint of blood will have been given during the latter stages of the operation and most cases will require a second pint on return to the ward

Following a combined excision of the rectum where the intestines have either been compressed and packed off inside the abdomen or exteriorized

through the wound and covered with saline packs, there is inevitably a degree of intestinal paralysis Until intestinal motility has been restored the intestine should remain empty and only minimal sips of iced water permitted to ease dryness of the mouth and thirst which however, will not be a feature if the body fluid requirements are well managed A patient will require on the average 4,500 mls of fluid in the first 24 hours and thereafter 3 000 mls which may be given in the form of a dextrose saline solution containing 4 3 per cent of dextrose and 0 18 per cent of saline He will be ready to take fluid by mouth when the abdomen is flat and soft to palpation and peristaltic sounds can be heard in all quadrants of the abdomen, or when it has been established that wind or faeces have been passed from the colostomy Thereafter, the patient can take increasing amounts of fluid by mouth and start a light diet

Re-establishment of Micturition

Male patients with carcinoma of the rectum are nearly always in the age group of benign prostatic enlargement and it is as well to have made searching pre operative enquiries into bladder function At the time of rectal examination any degree of prostatic enlargement should be noted Urinary retention complicates even minor operations on the perineum and groin and it is not surprising that it occurs after excision of the rectum Its incidence varies directly with the extent of the operation being far more common when the operation has included a panhysterectomy or pelvic and pre aortic gland clearance

A catheter will have been passed and the bladder emptied after induction of anaesthesia On return to the ward the catheter is connected to a St Mark s Hospital retained catheter apparatus This enables the bladder to be emptied and irrigated at regular intervals with the minimum of disturbance to the patient Re establishment of micturition can be expected on the fourth post operative day The indwelling catheter is therefore removed on the fourth post operative morning Male patients will find it easier to start passing urine again standing up by the bed and effective bladder contraction can be stimulated by an injection of Carbachol The amount of urine passed is still carefully measured and it is wise to test for residual urine 48 hours later Very occasionally a patient may be able to resume normal micturition in 24 hours This is indicated by the passage of urine alongside the urethral catheter If this happens the catheter may be removed at once

If the patient fails to pass urine following removal of the catheter on the fourth post operative day an indwelling catheter is replaced for a further three days Establishment of micturition is frequently delayed until the seventh to tenth post operative day If the patient cannot pass urine after this time paralysis of the bladder due to damage of the nervi erigentes should be suspected If the nervi erigentes have been injured retention will continue for three weeks and when the patient does start to pass urine there will be no control and he will have dribbling incontinence day and night A small transurethral resection of the bladder neck is often of great assistance in this type of bladder paralysis If, therefore, retention persists after the fourteenth post operative day a urolo-

gist familiar with the urinary complications of excision of the rectum should be consulted There is a natural tendency to postpone seeking help in the hope that the retention may be transient and in so doing the patient may suffer much unnecessary urethral instrumentation which might have been saved by an earlier consultation with the urologist

Infection of the urine occurs in almost 50 per cent of cases and the longer the period of retention the greater the risk of infection This infection is due to urethritis secondary to catheterization and rapidly clears up when a catheter is no longer required Urethritis may progress to cystitis and suppurative pyelo nephritis and when such extension of infection occurs the infecting organisms should be tested for sensitivity and the appropriate antibiotics given Serious infections of the urinary tract are more common in weak debilitated patients with large septic growths

On no account should the bladder be allowed to become over distended for this results in loss of bladder tone and contributes to retention and infection A distended bladder can cause separation of the lower end of the peritoneal suture line in a paramedian incision and the frequency with which a distended bladder is noted in cases of disruption of the abdominal wound of a rectal excision suggests that bladder distension is a contributory factor in wound disruption

Management of the Colostomy

The first time the patient s dressings are adjusted (a few hours after operation) the colostomy should be inspected to make sure that bleeding is not occur ring at the cut edge of the bowel or its mesentery and that the colostomy is viable and has not retracted

The colostomy may act immediately if post operative treatment has failed to relieve chronic faecal retention proximal to a constricting growth When bowel preparation has been effective no colostomy action can be expected before the third or fourth post operative day If after the fourth day there has been no colostomy action two glycerine suppositories may be inserted into the colostomy Aperients should not be given during the first post operative week No anxiety need be felt if the colostomy has not acted provided the abdomen is flat and peristaltic sounds are present If the abdomen is distended peristaltic sounds are absent and the patient complains of nausea a Ryle s tube should be passed into the stomach all fluids by mouth stopped and an intravenous drip re established If the abdomen is distended and vigorous peristalsis is present the causes of intestinal obstruction following excision of the rectum should be carefully considered The differential diagnosis between a paralytic and obstruc tive ileus following excision of the rectum is not easy and requires sound clinical judgment

A well constructed colostomy will soon function regularly although during the first 3–6 months the patient may experience teething troubles which usually take the form of colostomy diarrhoea If the intestinal contents become fluid disposable plastic colostomy bags (Down Bros) are invaluable to patient and nursing staff and the patient should be instructed in their use before returning

home Colostomy dysfunction is almost invariably due to a badly constructed tight colostomy It should be possible to pass an index finger covered with a finger cot into a colostomy without any feeling of resistance or discomfort to the patient

Perineal Wound

Healing of the perineal wound can take place by first intention or by leaving the wound partially open and allowing it to granulate The surgeon should be selective in the management of the perineal wound In tall thin patients with long mesenteries and lax tissues who have a small carcinoma of the rectum the reconstructed pelvic peritoneum and bladder drop back into the pelvic cavity almost completely obliterating it In contrast in a short obese patient with an advanced septic growth necessitating a very wide removal of the pelvic peritoneum the reconstructed peritoneal floor is stretched across the true brim of the pelvis and a very large cavity remains In the former primary suture and healing of the perineal wound is possible, in the latter, open drainage is essential *The criteria for successful primary closure of a perineal wound are the* minimum of dead space absolute haemostasis and absence of infection

By the very nature of the operation whereby the walls of the pelvic cavity are stripped absolute haemostasis allowing primary suture of the perineal wound is extremely difficult to obtain Although an occasional case may be dramatically successful, nursing sisters with a wide experience of these wounds prefer the perineal wound to be well drained, thus avoiding the difficulties of removing retained blood clots In the majority of cases it will be found necessary to drain the wound

During the first 24 hours blood and blood stained serum drain into the perineal dressings which should be changed when required On the third day the drainage tube is removed and the perineal wound is then irrigated twice a day with warm 2½ per cent Milton or 1/5 000 Bradazol solution The wound is thoroughly swabbed out with cotton wool to remove any blood clot that may be present A gauze swab moistened with the irrigating solution is then inserted up to the top of the wound

When the perineal wound is heavily infected as a result of a presacral abscess it is advisable to irrigate at least three times a day until the wound is clean A large granulating wound causes a secondary anaemia and it is advisable to check the haemoglobin level at regular intervals and correct the anaemia by iron and blood transfusion The stitches in the perineal wound should be removed on the seventh post operative day or earlier if there is any redness or cutting through around the stitch holes Occasionally the posterior part of the wound breaks down leaving a bridge of skin between this disunion and the drainage tube track If this occurs the bridge of skin should be gently broken down with a finger and the wound left wide open

General Management of the Patient

With discharge and moist dressings on the perineum great care and atten

tion must be paid to the skin overlying pressure points in the lumbosacral region During the first 72 hours the patient must be turned frequently from side to side and the skin in this region washed with soap and water dried and gently massaged with spirit and olive oil As soon as possible after operation the patient starts deep breathing and leg exercises under the supervision of a physio therapist Thrombosis in the veins of the soleus muscles can be detected early if the patient s calves are palpated each day and spreading thrombosis and emboli prevented by early anticoagulant therapy

The patient should be up and out of bed on the third or fourth post operative day *The seal on the abdominal wound should not be taken off until the* tenth post operative day when the stitches are removed Discharge of any significant quantity of blood stained serum from the wound at or before the tenth post operative day may be the first sign that the deeper layers of the abdominal wound have separated and that disruption is imminent

At the end of the second week, provided the abdominal wound has healed, the patient may have a bath and daily thereafter He will be fit to leave hospital between the third and fourth week after operation although the perineal wound will not be completely healed by this time During the subsequent three weeks convalescence the healing of the perineal wound will be complete and the patient able to return to work

2 Restorative Resection of a Rectal Cancer

Under certain well defined circumstances growths of the upper third of the rectum can be removed and the continuity of the bowel restored by anastomosing the upper pelvic colon to the remaining rectal stump This type of resection may be done in one two or three stages The staged operations may require a temporary colostomy to be performed either before excision of the tumour in order to prepare the bowel or at the same time as the excision of the tumour because of unfavourable circumstances arising during the operation or after a one stage operation if leakage occurs from an insecure anastomosis resulting in spreading peritonitis

The general management is the same as that of a combined excision the particular problem is the passage of faecal material through a low pelvic anastomosis

Most surgeons leave a drain from the site of the anastomosis following a restorative resection This drain may pass extraperitoneally from the anastomosis to a stab incision in the left groin or down behind the rectum in front of the sacrum and coccyx and out through an incision in the perineum between the anus and coccyx When there is spasm of the sphincter ani muscles or fibrosis of the internal sphincter muscle the anus will have been deliberately stretched at the end of the operation or an internal sphincterotomy performed

Some surgeons pass a rectal tube through the anastomosis to relieve gaseous distension of the proximal bowel This tube should be removed in 24 hours

Bowel Management

For the first 48–72 hours the fluid intake will be by the intravenous route and only sips of fluid by mouth allowed to allay dryness and thirst This affords the maximum of rest to the intestines during the period of temporary ileus and delays the passage of faeces down the colon to the anastomosis It must be remembered that the bowel at the lower end of the anastomosis will have no peritoneal coat, or will at the most have only a small peritoneal covering in front and although serous joined surfaces are sealed in 24 hours the anastomosis of a restorative resection will probably need 72 hours before it is set' and ready for faeces to pass over it Fluids may be taken by mouth after 48 hours provided the abdomen is not distended and peristalsis can be heard on auscultation of the abdomen If oral fluids are assimilated without nausea and the physical signs in the abdomen remain satisfactory, a light diet can be started on the fourth post operative day The patient will pass flatus soon after and the first bowel action can be expected between the fourth and seventh post operative days After the fourth post operative day if the patient experiences a desire to defaecate two glycerine suppositories may be inserted into the rectum If the bowels are not open by the seventh post operative day and the patient s condition is otherwise satisfactory cascara evacuant 5 minims may be given three times a day until the bowels act

Bowel irregularity can be expected for the first few weeks after a restorative excision and may persist for 3–6 months after operation During the early weeks the patient s control of defaecation may be imperfect On sigmoidoscopic examination granulation tissue usually surrounding a knot of unabsorbable suture material may be seen at the suture line 6 months to a year after the operation

Management of the Drainage 'Tube'

The best drain to use is a piece of Paul s tubing surrounding a strip of corrugated rubber 2–3 corrugations wide (Penrose type of drain) The object of this tube is to drain away blood and serum from the pelvic cavity and if necessary intestinal contents from an anastomotic leak The tube should not be removed or shortened until the sixth post operative day as the danger period for an anastomotic leak is between the fourth and eight post operative day Minor anastomotic leaks are not uncommon and consist of a little wind and faecal material being discharged along the drainage tube track These minor leaks are not associated with constitutional symptoms (rise of temperature and pulse abdominal pain and sickness) and nearly always close in 7–10 days Major leaks at the anastomosis give rise to abdominal pain vomiting increased pulse and temperature and these are an indication to do an immediate transverse colostomy to divert the faecal contents away from the anastomosis There is no need to digitate the anastomosis in a straightforward uncomplicated case for at least a month after the operation If a major leak is suspected in the post operative period a finger should be passed very gently up to the anastomosis and the site and degree of the defect determined

An abscess cavity may develop round the site of an anastomotic leak Drainage of such an abscess through a defunctioned rectum will be imperfect In these circumstances a proctoscope should be passed the defect in the anasto mosis identified and a soft rubber catheter passed through the defect into the abscess cavity which may then be irrigated with 1/1,000 acriflavine solution This should be done night and morning until the abscess cavity has filled in

Staged Operations

One to two weeks may elapse between a preliminary colostomy and resection of a rectal cancer During this period the distal colon and rectum may be thoroughly emptied and cleansed by irrigations through the colostomy above and the rectum below

A week after the resection the colostomy may be closed depending upon a satisfactory examination of the suture line In women the anastomosis should be palpated through the vagina as well as the rectum Occasionally a small abscess develops at the anterior suture line and bursts into the vagina causing a fistula between the rectum and vagina An unsettled temperature chart may suggest that this is happening Colostomy closure should be delayed until the temperature is settled and local conditions are satisfactory

3 Local Excision

Some malignant polyps of the rectum and small low grade squamous carcinomas at the anal margin may be removed by local excision After the snaring of a malignant adenoma from the upper third of the rectum its base should be carefully inspected to make sure that the bowel has not been perforated and haemorrhage is not taking place Before removing the sigmoidoscope the base should be lightly touched with a diathermy button The patient is allowed home on the following day but is advised to report to hospital immediately should he notice any blood in the stools

Following the local excision of a carcinoma at the anal margin the bowels are confined for two days and on the third post operative morning an enema is given Thereafter the wound is allowed to heal by granulation tissue It is irrigated with 2½ per cent Milton solution or 1/5 000 Bradazol solution twice a day The patient is up on the first post operative day and may go to the bath on the fourth post operative morning Early dressings are more comfortable if performed under light Trilene anaesthesia Skin grafting should be considered for patients with extensive wounds

CHAPTER XXI

SITING, CONSTRUCTION AND CARE OF A PERMANENT COLOSTOMY

IAN P. TODD

A PERSON who has a colostomy has to modify his life in many ways. The colostomy, to be of as little inconvenience as possible, should act regularly, completely and infrequently. To achieve this it must be well sited and constructed, and personal management must be intelligent. Time, care, correct diet, advice and not a little patience are requisite in order that colostomy regulation may be attained.

Siting of Colostomy

Considerable difference of opinion exists amongst surgeons concerning the ideal location for a colostomy. Three positions are in common use, viz. the umbilicus, the lower end of the midline or left paramedian wound used for excising the rectum, and the left iliac fossa. The latter site seems best to fulfil the requirements of correct construction for the following reasons. The stoma must always be directly visible to the patient; it should, therefore, be placed higher and more medially in large and fat individuals. The umbilical site is too prominent and too near the belt-line. When placed in the abdominal wound the colostomy is apt to be too low, may easily infect and prevent primary union in the incision, and the adjacent scar will render insecure the adhesion of bags should these be needed. An iliac colostomy must not be placed too close to the bony prominence of the anterior superior iliac spine. This implies that in a person of average build the colostomy is best placed in the left iliac fossa just above the medial to a point one half of the way along a line joining the anterior superior iliac spine with the umbilicus and stabilized in its position by being in contact with the lateral border of the rectus muscle sheath.

Construction

The ideal colostomy is a terminal iliac colostomy in which the colon passes directly without redundancy in the left iliac fossa through an adequate trephined hole *in the abdominal* wall *and is joined* to skin by primary mucocutaneous healing. A finger inserted into the colostomy should be able to pass straight through the abdominal wall and should not be obstructed by skin, fascia, aponeurosis or muscle. It is thus essential that the trephine hole through all layers of the abdominal wall should be made whenever possible *before* the abdominal wall is disturbed by an incision, and preferably before muscle relaxant drugs are administered. A circuitous passage of the bowel in the left

iliac fossa and through the abdominal wall does not form a 'valve , nor indeed is a valve desirable since obstruction is one of the causes of a constantly active colostomy The stoma should admit an average sized index finger

Colostomy retraction and colostomy prolapse are best prevented by fixing the mesentery of the colon to the abdominal wall Fixation can be achieved easily by combining it with obliteration of the space on the outer side of the colon by a purse string suture of thread, a factor which lessens the likelihood of intestinal obstruction due to herniation through this space An alternative and equally satisfactory method is the extraperitoneal colostomy where the freed colon, with its mesentery is passed extraperitoneally to the opening in the abdominal wall

About 1 inch of bowel should be free outside the abdominal wall which should be joined immediately to the skin by simple interrupted through and through direct mucocutaneous sutures This gives a colostomy which is almost flush with the skin thus avoiding a bulge and the likelihood of irritation and bleeding A protuberant stoma has no advantage as special adhesive appliances should rarely be required The more complicated method of suture advised by Lemmer and others is both unnecessary and dangerous No special care is needed to prevent the colostomy from acting early

Primary mucocutaneous healing prevents many cases of colostomy stenosis, which are commonly at skin level Secondary healing by granulation and scar tissue make narrowing more likely and thus ancillary incisions colostomy tubes and occlusive clamps should be avoided If the faeces are solid and of normal calibre progressive narrowing is rare and the insertion of a finger daily is unnecessary

Regulation of Bowel Action

There are two methods by which regularity of colostomy action may be achieved One way is by training and conditioning the bowel to act by natural evacuations once or twice a day This requires an understanding of the physio logical principles of normal defaecation The other way is more time consuming and is by washouts which aim at emptying the remaining colon completely to assure freedom from spontaneous evacuation for about 24 hours Each method has advantages and disadvantages

In a person with an intact large intestine faeces are moved from time to time by peristalsis along the colon into the rectum this period of increased motility of the whole intestine the gastro intestino colic reflex occurs each mealtime Whenever the reflex occurs faeces are moved along from one storage area of the bowel to the next The largest storage area in the large intestine is the rectum Contrary to general opinion in those with a regular once daily bowel habit it is empty for only quite a short period of time with each meal it fills partially its average capacity is the debris of three good sized meals a volume which distends the rectum excites its sensory area and evokes the call to stool An effective reflex to cause defaecation is partly conditioned but it is also related to the size of a meal and thus to the volume of faecal residue it produces Thus though an early morning hot drink or a cigarette may in many initiate the con

ditioned defaecation response almost every bowel is influenced either by excessive or by inadequate food intake With very small meals or when no food is taken, a weakened gastro intestino colic reflex occurs and little faeces is moved onward The faecal volume passing into the rectum is also reduced and the call to stool, sphincter relaxation and evacuation will be modified However the intricate mechanism of normal defaecation need not concern us here but just as a small meal causes a weak reflex response, so excessive indulgence initiates excessive intestinal activity and rapid faecal progession though a prolonged period of decreased intestinal movement may follow

In relating these facts to colostomy regulation it is at once apparent that the largest terminal storage zone has been removed, since normally more than one meal is eaten each day, more than one action must be anticipated furthermore regular meals producing a regular volume of faecal residue will tend to cause regular intestinal movement and bowel actions An irregular meal a low residue meal or abstention from food will be followed by some slight reflex peristaltic activity but may cause only a small irregular and unexpected action or even none at all A heavy meal is likely to cause an inordinate and prolonged peristaltic response and thus excessive and protracted irregular evacuation

The time and frequency of colostomy actions varies from person to person Commonly a motion is passed soon after getting up in the morning and again in the early evening Regularity of eating habits can condition this and if inconvenience is found, alteration of the major meal of the day from evening to midday may in time effect a satisfactory response

As in contrast to the normal bowel faecal volume has no marked effect upon regularity of the colostomy and as it is the volume of food eaten which initiates the peristaltic reflex, a relatively low residue type of diet will produce the least faeces an obvious advantage However, if this type of diet is usually taken a higher residue meal will produce more faeces but it is the irritant foods in particular which promote more peristalsis and upset the routine The highly spiced foods onions beans, green vegetables and fresh fruit cause increased motility Pureed root vegetables and stewed fruit are less laxative than in the fresh state Coconut tends to constipate It is unwise however, to anticipate an opinion about any food before giving it a trial This should be undertaken when convenient one article at a time

From what has been said it stands to reason that initially a colostomy almost certainly will act as the result of each meal taken Since immediately after operation feeding is often irregular and far from normal erratic actions are to be expected These may continue until the patient returns to familiar surroundings It is important to explain this and also that some modification of diet and habits may be necessary If patients do not understand this and particularly if they are not told they may alter their way of life unnecessarily and to their detriment

Just as a nomal person s bowel function is influenced by alterations of diet change of habitat and variations in activity, so the colostomy may be similarly affected Thus things which loosen the normal bowel tend to cause an excessive reaction in the colostomy whereas those that constipate evoke only a

lessened response For instance, many people are costive during the first few days of a holiday away from home such a reaction is less marked in a colostomy as also is the effect of a stay in bed Likewise unfamiliar food or unaccustomed strenuous exercise may provoke a more marked response than occurs in the normal bowel Any form of healthy exercise to which the person with a colostomy was accustomed prior to operation should of course be encouraged

Natural Evacuation

A natural evacuation is undoubtedly the simplest safest cheapest and probably the most convenient method for the colostomy patient Home follow-ups such as those carried out by Dukes have shewn that the happiest patients fall into this group Furthermore many adopt this method from experience even though washouts have been advised However the bowel which was irregular prior to operation may well be so afterwards Sedation may be required for an emotional anxious patient

Normal colostomy regularity should be accomplished without the use of drugs The stoma should not work continuously for there is no continuous progressive colonic peristalsis if activity is prolonged it suggests either colonic obstruction (usually a valved stoma) or stenosis It may occur also with intercurrent infections or recurrent disease

A well formed stool is much easier to deal with than a loose one If there is a tendency to real constipation, additional fruit (prunes figs or apples) or vegetables (spinach sprouts beans) together with a larger fluid intake should be tried A very mild aperient may be helpful magnesium hydroxide is usually the most suitable Liquid paraffin should be avoided it seeps and makes the colon inert Cellulose bulk laxatives help some people to become regular if they are used a small dose should be tried with a small amount of water after which no further fluid is to be taken for at least two hours The time of day it is taken is adjusted according to its result Codeine in any form is constipating

Should the colostomy action become too loose a plastic adhesive bag is helpful and a few of these should be made available to the colostomy patient They may also ensure a feeling of confidence if used when there is a particular engagement to be attended They should not however be a daily necessity

Colostomy Washouts

If it is deemed advisable to establish regularity by means of irrigations it is essential that the patient understand what is to be attempted To be effective a washout must remove all faecal debris from the colon and allow the washout fluid and mucus to be ejected before it can be considered complete Washouts are commonly required once daily but occasionally every second or third day may suffice They require from three quarters to one hour to carry out and should be done at a convenient time A satisfactory irrigation requires a certain degree of skill some apparatus and it is not without danger an intelligent patient and adequate facilities in the home are therefore essential Retention of

the washout fluid is common, as bowel bereft of its normal function, becomes atonic Return of fluid much later can be most inconvenient

The equipment required for colostomy irrigation consists of

1 A 2-pint douche can
2 One and a half yards of ¼ inch diameter rubber tubing and a connector
3 A soft No 12/14 Jacques rubber catheter
4 A regulating clamp
5 Lubricating jelly
6 A receptacle to receive the washout or a colostomy horn
7 Fresh dressing belt, etc

The washout may be given whilst lying down kneeling or standing though sitting on the lavatory is probably the most convenient method About a quart of lukewarm tap water is put into the douche can which is hung not more than 18–24 inches above the level of the colostomy opening Air is expelled from the tubing the tip of the catheter is lubricated and inserted just into the stoma The clamp is released and the catheter is inserted gently by moving it in and out with water flowing until 4 to 6 inches are within The washout is allowed to flow in slowly, and perhaps intermittently, at a rate which is found comfortable by experience It usually requires 5–10 minutes If pain is caused it suggests that the water is running in too fast and the douche can should be lowered The catheter is then withdrawn and a receptacle is at once held against the body Fluid and faeces are evacuated almost immediately, but it is advisable to wait a short while after the washout has been returned, to allow any remaining water to escape The patient soon becomes a good judge of when evacuation is completed Should a poor result be obtained from the washout the procedure may be repeated Some patients find a colostomy horn fastened to the body by a belt a neat and simple way of disposing of the faecal discharge directly into the toilet bowl Slow evacuation may be aided by gentle abdominal massage A saline or soap washout is usually unnecessary

Dressings and Apparatus

Dressings should be as simple as possible soft small and flat They are best made of absorbent cellulose wadding or tissue, cut into pieces about 4 inches square The wadding is cheap and highly absorbent, it can also be disposed of in the lavatory Many people use a small piece of gauze, lint or toilet paper, sometimes smeared with Vaseline directly over the stoma then the wadding and lastly a 6 inch square of waterproof oiled silk Colostomy cups serve no useful purpose and tend to cause prolapse and herniation If further support is desired an almost flat saucer of celluloid is ideal Sterile dressings are unnecessary

Many patterns of colostomy belt are now made The type advised will depend largely on the wearer s build They should however be waterproofed over the stoma and easily washable A simple nylon elastic two way stretch girdle with a zipp fastener flap over the colostomy, is the most acceptable but

if this does not give adequate support, reinforcement with boning is necessary Light airy night belts are also made but often a many tailed bandage may be more convenient

If faecal odour is a problem in spite of scrupulous local cleanliness, a small piece of absorbent material can be dampened with one of the chlorophyll deodorants and placed close to the stoma The patient should however be reassured that if he is clean, the odour of which he is conscious is seldom noticeable to others The patient who is by nature unhygienic is seldom con scious of odour If odour suddenly becomes pronounced it may be related to diet and a plastic bag containing a little deodorant fluid may be used for a while On the whole a firm belt reduces this worry Oral chlorophyll or charcoal is helpful occasionally

Care of the Colostomy Stoma and Skin

The stoma requires no special treatment, though it should not be allowed to suffer undue pressure upon it A little bleeding at the mucocutaneous junction is liable to occur from time to time but bleeding from within the bowel should be investigated at once Small surface grenulomata may be touched with the cautery A snug well fitted appliance reduces chafing

Frequent cleansing of the skin with bland soap and warm water and careful drying is the best method of avoiding skin soreness Almost any simple application such as zinc and castor oil cream will hasten healing of sore skin normal faeces are not unduly irritant

Baths may be taken preferably at a time when the colostomy is likely to be inactive Though one can be obtained no appliance is necessary for water will not flow into the bowel However when swimming the patient will probably feel more secure if a tiny dressing held in place with waterproof adhesive is applied

Summary

It must constantly be kept in mind that emotional stresses and strains unconsciously affect intestinal movements For this reason the colostomy patient needs to be instructed in the general ordering of his life as well as in the actual management of the colostomy At first there may be difficulties but these can generally be overcome with goodwill and patience Naturally a colostomy is always a handicap but in spite of this many colostomy patients adapt them selves successfully to their new way of life

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CHAPTER XXII

COMPLICATIONS OF EXCISION OF THE RECTUM FOR CANCER

H GORDON UNGLEY

THE complications of any radical excision of the rectum are necessarily related to the type of operation These are listed below followed by their complications

1 Sphincter saving Operations conducted wholly or partially through the Abdomen

In these operations a radical excision is performed without sacrificing the sphincter mechanism Three come under this heading

(*a*) Anterior resection
(*b*) Abdomino anal or pull through operations associated with the names of Babcock Bacon and others There is also the Maunsell Weir operation using the evagination technique of anastomosis
(*c*) Abdomino sacral excision in which the anastomosis is performed through the perineal wound after mobilization of the rectum from the abdomen Although as recently as 1956 d Allaines has published cases treated by this method it has generally been discarded in this country and America owing to the risk of a persistent faecal fistula in the perineum

2 Combined Abdominal and Perineal Excisions

In these methods the operation is completed by the formation of a terminal colostomy They can be placed under three headings

(*a*) The Miles abdomino perineal excision
(*b*) Synchronous combined excision
(*c*) Perineo abdominal excision

CLASSIFICATION OF COMPLICATIONS

1 Complications of the Abdominal and Perineal Excisions

Complications of the perineal wound
Complications of the colostomy
Genito urinary complications

2 Complications following Sphincter-saving Operations

Genito urinary complications
Pelvic abscess
Stricture at the site of anastomosis
Disturbance of rectal continence and bowel control

3 Abdominal Complications common to Both Types of Operation

Peritonitis
Ileus
Intestinal obstruction

Complications of the Perineal Wound

Complications arising in the perineal wound are responsible for a total mortality of approximately 1 per cent

Delayed Healing

Slow healing of the perineum may prolong post operative morbidity, but does not add to the mortality of the operation Obliteration of the pelvic and perineal cavity and the rapid healing of the perineal wound is assisted by free mobilization of a sheet of pelvic peritoneum which will descend to meet the newly formed pelvic floor (See Figs 73 and 74) Different methods of closure of the perineal wound have been tried since Miles first introduced his operation

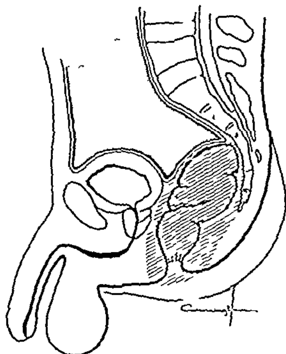


Fig 73

Normal male pelvis indicating extent of perineal cavity resulting from abdomino-perineal excision of the rectum

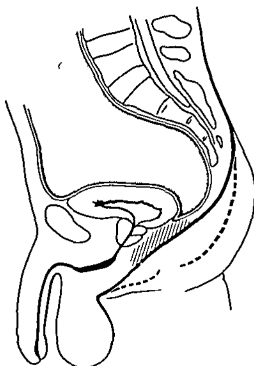


FIG 74

Diagram of male p lvis after operation to show descent of p ritoneum backward displacement of prostate and bladder altered position of the p rineal skin and the diminution of the perineal cavity

in 1907 He sutured the perineum round a gauze pack covered with oiled silk (see Chapter XII) This method produces a sound wound in which serious complications are uncommon however the dressings and irrigations during the first week or two may distress the patient and the healing of the wound is seldom complete in less than one month More recently the wound has been closed round a drain or tube (Cattel 1942 Crile 1950) sometimes in conjunction with suction irrigation or local chemotherapy and antibiotics The drainage tube is removed after 5 to 7 days and irrigation is not employed during the first week and may not be needed at all Only skin dressings are required and the wound heals more quickly The patient is usually able to leave hospital 3 weeks after the operation Complete closure of the perineum without drainage or with an extraperitoneal drain has been used but is not generally recommended

Infection

This is still the most frequent cause of delayed healing of the perineal wound but its incidence has been reduced by the use of pre and post operative antibiotics

Acute Infection

This is uncommon after an abdominal and perineal excision but is more frequent following the now rarely employed abdomino sacral operations in

which leakage may occur from the perineal anastomosis When acute inflammation does occur it should be treated by free drainage, if necessary laying open the whole wound and afterwards employing frequent irrigation

Chronic Infection

This is more common and is aggravated by loculation in the perineal cavity An unhealthy perineal wound should be thoroughly examined either under a short general anaesthetic in the operating theatre or, in milder cases a sigmoidoscope may be used with the patient in bed If sloughs or blood clots are found they should be removed by operation and any loculi broken down Free drainage should be established and subsequently the wound irrigated two or three times a day

Breakdown of the Perineal Wound

Separation of whole or part of the perineal wound may occur after operation if the peripheral circulation is poor, or has been impaired by the reflection of the skin flaps Infection alone or associated with a deficient blood supply may account for other cases of disruption The position of the patient in bed or *in a chair should be such as to avoid pressure upon the perineal wound*, the upright sitting position promotes the descent of the peritoneal floor and the early obliteration of the perineal space whilst avoiding pressure upon the wound Strapping of the buttocks with elastic adhesive plaster is helpful in preventing wound separation, particularly in debilitated subjects, in such patients the skin sutures should be left in for longer than usual Occasionally a secondary suture of the perineal wound is required

Persistent Sinus

This is uncommon but if, one month after the operation a deep perineal sinus persists, it should be carefully inspected to make certain that no blood clot or foreign matter such as a ligature is present *Gentle curetting of the wound may assist it to heal*

Perineal Urinary Fistula

(See Complications of the Urinary Tract)

Perineal Faecal Fistula

This complication sometimes follows sphincter saving operations of the abdomino sacral type and is due to the breakdown of the perineal anastomosis It is accompanied by a virulent cellulitis and may be fatal

Following perineal excision it is a recognized but uncommon sequel After abdomino perineal excision a faecal fistula is very rare but has been recorded when a loop of bowel has passed through a gap in the suture line of the peritoneal floor and become strangulated, excessive suction on the perineal drain may encourage this The obstruction is usually recognized at an early stage and relieved by an emergency laparotomy before the fistula has occurred

Perineal Hernia

This rare complication is recognized as a bulge when the patient stands or coughs and may become quite large The hernia is due either to widespread destruction of the tissues by infection or previous operation often gynaecological resulting in a weakness of the perineal floor through which a peritoneal sac protrudes Excision of segments of the sacrum as in the old Kraske operation, often caused herniation but excision of the coccyx does not appear to have any influence on the development of perineal herniae

Cases with a slight bulge require no treatment but if the hernia is larger support may be provided by a perineal strap from the colostomy belt or corset In severe cases the peritoneal sac should be excised and the defect in the pelvic fascia repaired either through the perineum or by a combined abdominal and perineal approach (Cattel 1944)

Haemorrhage

At operation it is important to control bleeding particularly if the blood pressure has been lowered below 100 mm of mercury It has been found that hot (120° F) lotion—first 1/500 perchloride of mercury followed by saline at the same temperature—is helpful in achieving haemostasis Ligation of the anterior division of the internal iliac artery on each side is sometimes employed to prevent haemorrhage in the pelvic and perineal stages of the operation particularly where massive infiltrating tumours or secondary inflammatory complications are present or if removal of the uterus or bladder is also contemplated (Abel 1957)

Reactionary haemorrhage is uncommon and is treated by removal of clot and irrigation with hot saline In some cases ligature may be required

Secondary haemorrhage is due to sepsis and is uncommon If a large squamous epithelioma of the anus has been excised by diathermy secondary haemorrhage sometimes occurs

COMPLICATIONS OF THE COLOSTOMY

Although the severe complications of a colostomy will be described in detail it is satisfactory to be able to record that they are rare and that a well-made colostomy is soon managed by the patient and is compatible with a normal healthy life The complications may be classified into two groups

Early

1 Retraction—(*a*) Complete (intraperitoneal)
 (*b*) Partial (subcutaneous or intramuscular)
2 Sloughing which includes some cases of retraction
3 Perforation
4 Lateral space intestinal obstruction

Late

5 Stenosis
6 Prolapse
7 Herniation—Pericolostomy hernia

Early Complications of the Colostomy

Retraction

This is mentioned first as it may be an alarming and dangerous complication of a colostomy It is now common practice to suture the skin to the mucous membrane of the colostomy rather than to allow the two epithelial surfaces to grow across the granulating area which develops around an unsutured, extruded end of bowel This suturing diminishes the tendency to stenosis as there is less fibrous tissue formed, but it could increase the chance of retraction, if performed upon unsuitable cases

When this method of mucocutaneous suture was first proposed by Patey in 1951, he gave the following contra indications to its use

1 Pre existing intestinal obstruction
   It is plainly undesirable to suture distended bowel to skin owing to the contraction and retraction which takes place when the colostomy is opened
2 Inadequate preparation of the bowel which has left the colon full of faecal masses Again there is the danger of the colon retracting into the abdominal wound when the bowel is emptied
3 Gross obesity
4 A short colon mesentery such as is commonly present with diverticulitis
5 A weak blood supply to the colostomy

Appreciation of these factors is important in avoiding retraction and in the presence of any of them it is wise to mobilize a sufficient length of colon to protrude at least 2 inches beyond the skin surface (instead of the usual 1 inch) and to ensure that the blood supply is intact for the whole of this length of bowel A glass rod through the mesentery is a safer method of anchoring the bowel than suturing, in these particularly awkward cases A secondary suture of the mucocutaneous junction can be made at a later date when the bowel is stabilized in its position and the risk of retraction has passed for example 5 to 7 days later

The treatment of retraction of the colostomy varies with the degree If there is marginal sloughing or only slight retraction of the colon into the abdominal wall but still a clear and firm opening there is no reason to interfere in the immediate post operative period At a later date if stenosis occurs the colostomy can be refashioned when the patient is convalescent If on the other hand the retraction is so severe that the colostomy is almost, if not quite out of sight or if there are signs of peritonitis an immediate laparotomy should be performed at the site of the colostomy by an oblique muscle-cutting incision

extending from the stoma (if the colostomy is in the left iliac fossa) A piece of viable colon is mobilized which can be safely withdrawn without tension, through the abdominal wall A paramedian incision is an alternative (which must be used with a transverse colostomy), but usually an extension of the colos tomy wound is adequate and is more easily and quickly performed If con tamination of the peritoneum has occurred it is dealt with by sucking out pus or infected fluid using local and parenteral antibiotics intravenous therapy and providing drainage if necessary This serious complication is rare

Sloughing

This may be due to torsion or tension of the colon or its mesentery during the fashioning of the colostomy or to sutures occluding blood vessels in the mesentery during the anchoring of the bowel or the closing of the lateral space Occasionally cardio vascular disease and a poor peripheral circulation are re sponsible for the necrosis especially in a cardiac patient who may be throwing off small emboli

The impairment of the blood supply may be complicated by or be the precursor of a virulent cellulitis which further increases the destruction of the tissues The unhealthy condition of the colostomy will be recognized at an early stage when daily inspection of the bowel is made on routine rounds by those attending the patient It will be seen that the bowel has become glazed and bluish purple in colour At a later stage a grey necrotic condition with a foul smelling discharge develops surrounded by a painful red swollen in durated abdominal wall

Unless the necrosis is plainly a superficial and limited one there is no safe alternative but to operate exposing the colon far enough to enable healthy bowel to be withdrawn and anchored to the abdominal wall after severing the necrotic portion Local antibiotics and chemotherapy as well as parenteral injections are of value in assisting recovery but are never an alternative to surgery where peritonitis has occurred

Perforation

This complication is mainly confined to those patients who practise daily washouts of the bowel but it does occur rarely where an enema has been given via the colostomy to relieve constipation Patients and nurses should always be warned against inserting the enema nozzle itself into the bowel as there is con siderable risk of perforation Even when a rubber catheter or rectal tube is attached to the enema syringe in the approved manner there is still need for great care and gentleness Most surgeons prefer a tube and funnel to be used rather than an enema syringe In either case it is desirable to inject water ahead of the tube whenever possible as this guides the catheter on its way into the bowel and makes the insertion easier

When a perforation occurs it is usually at the attachment of the colon to the abdominal wall the junction of the fixed and the movable part of the colon The enema fluid is injected into the peritoneal cavity instead of the lumen of the

colon The patient complains of immediate pain generally over a wide area of the abdomen and this is soon followed by symptoms and signs of peritonitis As a rule the catastrophe is recognized at an early stage and prompt treatment brings about recovery As soon as a perforation has been diagnosed an immediate laparotomy is required The site of the perforation is exposed and the adjacent colon is mobilized well above it and also down to the colostomy stoma When the bowel has been isolated from the abdominal wall it can be threaded through the original opening and anchored at a point above the perforation The colostomy is then fashioned as before If there has been gross peritoneal soiling, this can be dealt with in the usual way

The incidence of perforation over a 10 year period was 9 in 657 operations, of these perforations 3 were fatal

Lateral Space Obstruction

This term refers to the trapping of a loop of small bowel in the space between the left iliac colostomy and the left lateral margin of the peritoneal cavity that is, in the left paracolic gutter Where the colostomy is more centrally placed through the lateral margin of the rectus muscle, the intraperitoneal space is wide enough to admit loops of gut without restriction and obstruction is almost unknown For many years surgeons using a left iliac colostomy have practised a formal closure of the lateral space at the time of the abdominal operation Sutures are placed in the mesentery of the descending colon going to the colostomy taking care not to damage the blood supply The parietal peritoneum can be picked up and brought across to the bowel and mesentery without difficulty Another technique which avoids this complication is the extraperitoneal colostomy

This form of intestinal obstruction develops more often from a loop of small bowel passing into the lateral space from below rather than a coil entering from above The development of obstructive symptoms and signs is often rather insidious if it takes place in the first week or two after the excision of the rectum Unless careful physical examination is made the obstruction may be mistaken for ileus or a low grade peritonitis or just the delayed function of the colostomy Over the years surgeons have become more alert to the possibility of a lateral space obstruction and once suspected it is now seldom missed An early laparotomy instead of a late one may mean saving instead of losing the patient

Other early but rare complications of colostomy are as follows

Wound Infection

Slight infection of the marginal skin with sometimes a little induration round the colostomy is seen from time to time but in the absence of retraction or sloughing of the colostomy this is rarely more than a superficial cellulitis

Peritonitis in the region of a Colostomy

Local peritonitis around a colostomy may occur in association with sloughing or retraction or from perforation of the colon where an enema has been given Apart from these major events which are dealt with above intra abdominal

reaction around a colostomy is most unusual If local peritonitis does develop it may be controlled by antibiotics but when progress is not satisfactory an exploratory incision will be required to make sure that there is not a collection of pus requiring evacuation

Colostomy Fistula

Although this condition is seen around an ileostomy from time to time it is extremely rare in association with a colostomy Usually it means that the sutures anchoring the colon to the abdominal wall have been placed too deeply and tied too tightly and have caused a necrosis of the wall of the colon in its passage through the parietes

Secondary Haemorrhage

This again is a rare event but may occur where sloughing or retraction of the bowel has taken place

Late Complications of a Colostomy

Stenosis

This is a trying complication which was more common before the mucocutaneous suture was widely adopted The most common site of the narrowing is at the mucocutaneous junction Less commonly the stricture occurs in the passage of the bowel through the abdominal wall In the superficial type at the skin margin the most effective operation is to remove a ring of tissue including the scarred and contracted ridge where skin joins mucous membrane The two edges are then sutured with interrupted fine catgut after which it is rare for the condition to recur

When the colostomy is constricted in its passage through the abdominal wall it may be necessary completely to refashion it but as a general rule these cases are quite easily managed by daily digital dilatation by the patient A satisfactory plan is for the patient to perform this digitation immediately before proceeding with his washout as this facilitates the passage of the catheter or if he is not using a washout the dilatation can be done once daily before or after a bowel action

Prolapse of a Colostomy

This is uncommon either in a terminal or a lateral colostomy It may be mucosal or less often a complete procidentia of the bowel may occur It may happen when a large loop of colon is present immediately above the stoma in a terminal colostomy or on either side of a loop colostomy In a loop colostomy the prolapse sometimes presents from the *lower* end Too large an opening in the abdominal wall also contributes to prolapse Prolapse is uncommon using the present day technique of fashioning a terminal colostomy where quite a small circle of skin and subcutaneous tissue is removed followed by splitting of the abdominal muscles and suturing of the bowel to the peritoneum to the muscles and to the skin It is also extremely uncommon in the extraperitoneal

terminal colostomy mentioned above A point of technique in an intraperitoneal colostomy is to suture the peritoneum accurately around the bowel seeing that the muscles also are snug to the colon

Treatment of prolapse often consists of reassurance to the patient and instruction to continue wearing a colostomy belt perhaps accompanied by an extra pad over the stoma As a rule nothing more is required Where the protrusion is a nuisance it can be dealt with by multiple ligations of the prolapsed mucous membrane (as in Goodsall s operation) but most surgeons prefer to carry out a formal refashioning of the colostomy

Peri colostomy Hernia

This is a prolapse of the colon around the stoma the colon and sometimes the small bowel herniating between the layers of the abdominal wall where the muscles have been cut or split at the original operation The protrusion may vary in size and can become quite large (Fig 75) The bowel is covered as a rule only by a peritoneal sac and skin Although unsightly when the patient stands without wearing a belt the hernia rarely causes much inconvenience being



Fig 75

Pericolostomy hernia ten years after abdomino-perineal excision (transperitoneal colostomy)

effectively controlled by the ordinary colostomy belt The tortuous course of the colon through the hernial sac may necessitate a little more manipulation of the tube if colon washouts are employed Intestinal obstruction has been described in connection with peri-colostomy hernia but the author has never seen such a case

In the unusual event of an operation being required for the hernia it is better to refashion the colostomy from the peritoneal cavity to the skin and it may be advisable to bring it out through a new opening in the abdominal wall Various techniques have been devised to prevent this complication The excision of a disc of subcutaneous tissue and of the external oblique muscle in addition to the circle of skin is perhaps an advantage the internal oblique and transversalis muscles are then split in the usual way By this method it is hoped that adhesions will form between the skin and the muscle to prevent peritoneal protrusion between the layers With the object of reducing the incidence of pericolostomy hernia the colostomy is sometimes placed just within the lateral margin of the rectus sheath dividing some of the lateral fibres of the muscle Probably the best method of preventing herniation in a terminal colostomy is to use the extraperitoneal method of fashioning it as described by Patrick Sames (1958)

Other Late Complications of a Colostomy

In a series of 657 cases of excision of the rectum simple polypi presented at the colostomy in 5 patients and were easily removed A small superficial fistula occurred at the side of the colostomy in 2 patients and a secondary growth developed at the colostomy in 2 other cases

Genito-Urinary Complications

Urinary Complications

Urinary complications following abdominal and perineal excision and sphincter saving operations will be considered together as there is no important difference between the two except that after the latter these complications are generally thought to be less frequent The two main groups are injury to the urinary tract and post operative retention of urine

Injury to the Urinary Tract

Injury may occur by sacrificing part of the tract in an endeavour to eradicate disease *e g* a section of ureter may be removed with the growth or a partial or even a total cystectomy may be required Sometimes a prostatectomy is necessary to complete the radical excision of an advanced growth On other occasions the opening into the urinary tract is made accidentally while carrying out a difficult operation

These injuries can be classified as follows

1 To the ureter 2 To the bladder 3 To the urethra

1 Injury to the Ureter

The ureter is usually damaged (or resected) either at the brim of the pelvis near the superior haemorrhoidal vessels, or lower down on the lateral pelvic wall, when the lateral ligaments of the rectum are divided It is rare for the ureter to be injured during the perineal part of an excision when injury does occur it is nearly always during the pelvic portion of the abdominal operation There are various factors which may render a ureter more prone to injury First will be mentioned a rare congenital abnormality The ureter may be duplicated on one or both sides The ureter may be double down to the bladder with separate openings or one may open into the other Occasionally the ureter ends blindly More rarely three ureters are present on one side

Conditions which make the operation technically more difficult also increase the likelihood of damage to the ureter The presence of obesity, particularly if combined with a narrow pelvis or a large bulky growth, may make the operation hazardous Previous operations within the abdominal cavity, leaving scarred and perhaps displaced structures may make it more difficult to identify and preserve the ureters

In any of these circumstances the ureter may be included in the so called Rubicon ligature of the superior haemorrhoidal vessels Inspection of the left ureter after the two ligatures have been placed, but before they are tied is important Where dissection of the superior haemorrhoidal vessels is carried out from the left side the ureter is clearly seen and can be avoided If, however, the field of the operation on the left side is obscured by scar tissue from previous operation and the operator decides to isolate the pedicle from the right it is very easy for the ureter to be taken up in the same plane as the vessels and included in the ligature It is standard practice in carrying out a radical operation upon the rectum to demonstrate the ureter on each side and to dissect the peritoneum from it right down into the pelvis This avoids damage to the ureter when dividing the lateral ligaments If inflammation or extension of the growth envelops the ureter (more often the left one) it is advisable to dissect the ureter above the point of involvement and trace it into the mass Similarly it can be dissected from below upwards During the isolation of the ureter its blood supply is carefully preserved and it should never be stripped close but always left with a few vessels on its surface Close dissection of the ureter may cause necrosis and a fistula

If a ureter is cut or divided by accident or if a portion of it is removed the injury can be dealt with in one of the following ways

Ligation of the Ends

Where there is a healthy kidney on the other side it is better to carry out this simple operation if the longer procedure of restoring continuity or transplanting the ureter will endanger the life of the patient Occasionally after ligature the kidney will atrophy and cause no trouble In other cases ligature

is followed by hydronephrosis sometimes by pyonephrosis and not infrequently by a urinary fistula It is only when these complications arise that nephrectomy is necessary but, by this time the patient has usually recovered from the original operation and will tolerate the nephrectomy

Immediate Nephrectomy

This is not advisable as it seems an unnecessary risk at the time of the rectal operation

Preservation of Renal Function

(*a*) *By implantation of the divided ureter into the bladder* This is undoubtedly the method of choice If division of the ureter occurs near the lateral ligament of the rectum or by the cervix uteri there is sometimes sufficient length to permit re implantation into the fundus of the bladder This can be done by splitting the end of the ureter and suturing the flaps to the bladder mucosa or a mucosa to mucosa apposition may be made The latter method is particularly suitable if the ureter is dilated In either case anchoring sutures are placed between the outer coat of the ureter and the outer wall of the bladder care being taken not to kink or constrict the ureter The method of threading the divided ureter through the remaining intramural stump (Campbell Begg 1953) is seldom applicable owing to loss of length of ureter

(*b*) *Anastomosis—Ureter to Ureter* Where there is no loss of tissue e g after accidental division of a ureter the divided ends may be joined by an end to-end anastomosis after cutting them obliquely A ureteric catheter is introduced with a cystoscope and passed above the point of injury and then attached to the indwelling Foley catheter (Badenoch 1959) The divided end of a ureter has been joined to the side of the opposite normal one but this is generally considered less favourable than an end to end anastomosis

Where loss of tissue precludes anastomosis or implantation into the bladder a decision has to be made between ligation cutaneous ureterostomy or implantation of the ureter into the colon or ileum

(*c*) *Implantation into the Colon or Ileum* If anterior resection has been performed the ureter can be implanted into the colon above the anastomosis If, on the other hand a colon implantation will leave the patient with a wet colostomy it is better to ligate the ureter provided that the other kidney is healthy The use of ileum either to restore continuity between ureter and bladder or to make an artificial bladder with a separate stoma on the abdominal wall is a lengthy procedure which few surgeons would consider advisable at the time of the excision of the rectum It is possible to bring the ureter to the skin as a temporary ureterostomy and at a later date to carry out the ileal implantation if suited to the case It will be seen from the above that a pre operative intravenous pyelogram is of immense advantage should serious urinary complications arise

2 Injury to the Bladder

Where the rectal growth is adherent, it may be possible to achieve a radical excision by sacrificing a portion of the fundus or lateral wall of the bladder (Pyrah 1951) More often, if the growth is advanced, it is the base of the bladder which is involved, together with the prostate and seminal vesicles, or the uterus and vagina In this event the following alternatives should be considered relative to the case

(*a*) Total pelvic exenteration with diversion of both intestinal and urinary channels
(*b*) Excision of the growth as widely as possible, leaving the bladder intact even if apparently involved
(*c*) Palliative colostomy only
(*d*) Laparotomy

It should be remembered that apparent malignant infiltration may on investigation, prove to be merely inflammatory

It is rare for the bladder to be damaged accidentally, due to the universal practice of emptying it on the operating table by catheter before any pelvic or lower abdominal operation However, the bladder may sometimes be opened accidentally during a difficult dissection If it is sutured immediately (in two layers with catgut) and an indwelling catheter is left in for a week or two after the operation the opening will usually close Occasionally a perineal fistula persists and in these cases it is probably better to carry out transurethral resection of the bladder neck *Even a slight degree of obstruction is sufficient* to maintain a bladder fistula

3 Injury to the Male Urethra

This may occur either at the bulb or in the prostatic urethra

The Bulbous Urethra

This is a rare injury and is usually recognized at the time of the operation If the edges of the urethra are sutured with fine catgut in two layers primary union usually results In the event of a fistula developing the patient is fully continent but has a perineal leakage during micturition An indwelling fine plastic catheter or a long polyvinyl tube (Gibbon 1958) into the bladder may cure the condition but such a fistula often *persists until the perineum* is fully healed

The Prostatic Urethra

This may be damaged in cases where the prostatic capsule has been invaded by the rectal growth and a portion of the gland has been shaved off in an attempt *to eradicate the disease* A week or two later the thinned wall of the prostatic urethra may give way particularly if diathermy has been used at the excision The resulting fistula is often cured by the use of an indwelling catheter but

usually not before the perineum has closed down Occasionally a perineal prostatectomy is required or a transurethral resection of the bladder neck

Post-operative Retention of Urine

This is a complication which may occur after any abdominal or pelvic operation and it is not surprising to find that it is a fairly common sequel to abdomino perineal excision of the rectum

Although this sometimes follows the excision it is only rarely that normal urination does not return before the patient leaves hospital Marshall (Marshall 1946) gives the incidence of urinary difficulty following 600 consecutive cases of excision of the colon and rectum as 25 per cent of the patients failing to urinate normally after removal of the indwelling catheter on the seventh day and 10 per cent having difficulty for more than three months

There are various factors which increase the likelihood of retention one of them being a displacement of the viscera of the pelvis when a radical excision has been performed The bladder bladder neck and the prostate fall backwards on the axis of the perineal membrane with the result that the normal curve of the urethra is obliterated and a cystoscope entering the bladder does so at an angle of 60° to the horizontal when the patient is lying flat (Innes Williams 1952) There is no displacement in the female urethra even when a hysterectomy is performed as well as an abdomino perineal excision The alteration of the course of the urethra is illustrated in Figure 76 and also Figures 73 and 74

Although there is no obstruction associated with this changed anatomy the recumbent male patient is obliged to pass his urine almost vertically upwards from the bladder Patients should therefore be encouraged to get up to urinate and to lean forward if they have any difficulty

Trauma to the Bladder Base and to its Nerve Supply

A minor degree of bruising may injure the musculature of the bladder and some of the nerve fibres to it This will produce an imbalance resulting in mic turition troubles such as may occur after any pelvic operation A temporary loss of detrusor power occurs as shown by a poor stream and residual urine Catheterization indwelling for 5 to 7 days will usually allow the bladder func tion to return to normal

Pelvic Nerve Syndrome

In pelvic nerve syndrome the automatic nerve supply to the bladder and urethra has been damaged during the pelvic dissection It is not at all certain how this occurs but in some cases it may follow dissection on the outer side of Waldeyer s fascia in a difficult case with infiltration of the pelvic wall

Fortunately this distressing complication is very rare

Clinical features of the Pelvic Nerve Syndrome Briefly retention of urine is followed by incontinence but whereas in prostatic patients this overflow incontinence disappears when the retention is relieved in pelvic nerve cases the incontinence persists even when there is no retention The patient has no sense

Investigations

Cystoscopy The bladder neck is relaxed and the posterior urethra constantly filled The cystoscopic appearance is characteristic the lip of the internal meatus being smoothed out

Cystometry This demonstrates a moderate or large bladder capacity with a steady rise of pressure during filling There is no isotonic phase or it is very short The patient has no sense of bladder distension

Cystogram This demonstrates a relaxation of the internal sphincter and the filling of the posterior urethra

Mechanism of Incontinence

The incontinence following the pelvic nerve syndrome is considered by Innes Williams (Innes Williams 1951) to be the result of a paralysed internal sphincter a displaced and therefore less efficient external sphincter and finally the failure of the detrusor to relax Control is sometimes regained during the day but not maintained at night when the voluntary muscles are relaxed during sleep

Treatment

A penile bag or clip is of value while the patient is regaining control both during the day and at night

It has been pointed out by Marshall (1946) that in cases of pelvic nerve syndrome a perineal pad often helps the incontinence by restoring the prostate and urethra toward the normal position In some patients he has performed suprapubic suspension of the bladder and bladder neck by suturing them to the retropubic periosteum and the posterior rectus sheath

The late follow up of pelvic nerve syndrome reveals that many of these patients regain a certain sensation of bladder fullness after months or years have passed e g a dull pain in the groin may be an indication of the full bladder and serve as an adequate warning to the patient

Treatment of Post operative Retention of Urine

Cases of transient retention are seen some requiring trans urethral resection or even prostatectomy but the majority recover with catheterization and control of urinary infection The prevention of post operative distension of the bladder is of prime importance Once the bladder wall has been strained it may take months of careful treatment to restore its normal emptying capacity and during this time residual urine and repeated catheterization make infection almost inevitable For this reason it is better to leave an indwelling catheter post operatively for a period of about 5 days The catheter may be of the Foley type of latex rubber or a Harris type of plastic material which is probably less irritating

During this period of catheterization the urine should be withdrawn every four hours by releasing the spigot or an underwater seal can be arranged with a Dukes apparatus The third alternative is to use a fine polythene catheter

5 feet long connected to a disposable plastic collecting bag and retained in position by a special adhesive fixing to penis or vulva (Gibbon 1958) This apparatus reduces the risk of infection of the urinary tract as it is so small that it does not traumatize the urethra and there is a complete seal in the passage of urine from the bladder to the plastic bag

The post operative routine employed to prevent retention is as follows

An indwelling catheter is inserted on the operating table and left in for 5 days If the patient has difficulty in passing urine after removal of the catheter, detrusor stimulating drugs are employed, such as prostigmine and carbachol by injection at first and later, if necessary, by mouth If normal micturition has not returned or if residual urine is over two ounces the catheter is replaced for a further 5 to 7 days Chemotherapy or antibiotics are used to control any urinary infection If, after an interval of 4 weeks the patient is not passing urine naturally, or if he is only doing so with residual urine of more than two ounces then cystoscopy should be performed If this reveals bladder neck obstruction or intravesical enlargement of the prostate a trans urethral resection is advisable If, on the other hand, the bladder appears normal, conservative measures are continued as many patients regain normal micturition without operation If residual urine persists a small trans urethral resection of the bladder neck should be considered

The Enlarged Prostate in association with Carcinoma of the Rectum

If it is known that prostatic obstruction exists prostatectomy is occasionally performed prior to the excision of the rectum However, it is not generally advisable to defer the operation for cancer also prostatic symptoms sometimes become less prominent after abdomino perineal excision, owing to the displacement of the bladder and urethra (see Figs 73 and 74) An exception may be made where the rectal growth is early the prostate large and the patient in good condition In such an instance a retropubic prostatectomy, prior to the rectal excision may be the best treatment More often, however, the patient is old not a good surgical risk and the prostate of the small fibrous type which is better dealt with post operatively by a trans urethral resection if the patient does not regain normal micturition

Treatment of Prostatic Obstruction

Rectal operations for cancer are commonly performed on patients at an age when prostatic symptoms are prevalent and the rectal operation may aggravate a minor urinary disability With care most patients can be coaxed back to effective micturition and eventually make a full recovery without operation If however an operation is necessary, one of the following is chosen either Trans urethral resection or Retropubic Prostatectomy

Where there is a large adenomatous prostate this operation may be better treatment than trans urethral resection, but each case must be judged on its merits

Other points regarding prostatic disease and treatment relative to excision of the rectum are as follows

Perineal Prostatectomy

If prostatectomy is performed during the perineal stage of the operation there is a tendency for a urinary fistula to develop If this occurs the perineum closes more slowly and even when it is almost healed the urinary leakage may persist for some months

Prostatic Calculi

These can satisfactorily be removed during the perineal operation by a vertical incision into each lobe The prostate shrinks down and obstruction is relieved

Disturbance of Sexual Function

Disturbance of sexual function may follow excision of the rectum but this is more correctly described as an occasional sequel than as a complication of the operation

Some patients manage their colostomy well and it does not handicap their sexual life but others are not so fortunate The degree of embarrassment depends partly upon the mental adjustment that is made by the patient and by his or her partner, and partly upon the degree of bowel control that is achieved with or without a daily washout

In the female an excision of the rectum with or without a colostomy does not usually upset sexual life unless the vagina has to be resected in which case it is not always possible to leave a normal introitus In the male it is important to remember that the majority of patients have reached an age when their sexual activity has diminished or even ceased prior to operation

In any investigation of post operative sexual function allowance should be made for a period of inactivity during convalescence as after any major operation The mechanism of sexual disturbance is presumably due to damage to the nervi erigentes—either in their course from the presacral nerve across the wall of the pelvis or where the seminal vesicles are laid bare in the pelvic dissection It is quite certain that disturbance of sexual function can occur without any technical error in the pelvic operation one cannot necessarily attribute it to dissection on the wrong side of Waldeyer s fascia It is not easy to find a way of completely eliminating this unfortunate sequel as the autonomic nerves are indistinguishable from the fascia and lymphatic tissues of the pelvis Furthermore the essence of a radical excision for cancer is a block dissection of the bowel with adjacent cellular tissue and lymphatic glands

Effect of the type of Operation

The incidence of sexual disturbance following sphincter saving operations is generally thought to be less than after abdominal and perineal excisions

Clinical Features

It should be remembered that orgasm may be obtained but there may be a failure to ejaculate In Goligher's series (1951) a useful summary was made to the effect that of the patients previouslly sexually active roughly one third became impotent, one third were potent but sterile and one third were unaffected by the operation

COMPLICATIONS FOLLOWING SPHINCTER-SAVING OPERATIONS

Genito urinary Complications

(See under abdominal and perineal excision)

Pelvic Abscess

After Anterior Resection

Following an anterior resection pelvic abscess is infrequent, but when it does occur it usually arises from leakage at the suture line It is probably true to say that this is more often caused by necrosis due to tension combined with an inadequate blood supply than by inaccurate stitching There is, as a rule, no difficulty in obtaining a sufficient length of left colon to allow both a radical excision and an anastomosis to the rectum without tension but in some cases it is necessary to mobilize the splenic flexure to achieve this end

The operation is unsuited to the fat subject with a small pelvis In difficult low anastomoses under these conditions separation of the suture line is more likely to occur and lead to a pelvic infection Even with the utmost care cases of leakage undoubtedly occur but with thorough pre operative bowel preparation and the provision of extraperitoneal or transperitoneal drainage to the suture line the infection is as a rule controlled, the anastomosis heals and functional continuity is restored

After the Pull Through Operation

Pelvic cellulitis and peritonitis following the pull through operation occur in about 10 per cent of cases (9 in 91 operations) according to the Mayo Clinic figures quoted by Bacon These infections have occurred less often since suction on the perineal drain for 5 to 6 days has been employed and combined with the use of suitable antibiotics

Where an abscess has occurred, it can usually be drained through the anal canal but if necessary free drainage may be established by a separate perineal incision It is wise to delay the final trimming of the colon stump until the inflammation has subsided

Even with the most careful regard to blood supply and absence of tension some necrosis of the colon will occur in a percentage of the cases Bacon (1956) who is undoubtedly one of the most enthusiastic exponents of the pull through technique records in his series (with a total mortality of only 3 9 per cent) that some sloughing occurred in 19 out of the 91 cases This may at first sight seem

to be a considerable fraction but he goes on to say that the condition was not severe except in 4 patients who developed faecal abscesses 3 of them needing a colostomy In one of these 3, death occurred It is probable that with such a length of colon protruding thrombosis may occur in the marginal artery in the immediate post operative period of hypotension particularly in poor risk subjects Where the nutrition of the colon appears to be precarious the protruding piece of colon may be left for several weeks before it is finally trimmed

After Abdomino Perineal Excision

Pelvic abscess is extremely unusual after abdominal and perineal excisions unless complete closure of the perineal wound without drainage has been performed

After Extended Hartmann Excision

After this operation in which a short anal or ano rectal stump is left pelvic abscess sometimes occurs

Stricture

This may follow an anterior resection but it is readily amenable to dilatation one of the most useful instruments being a Hegar dilator Once the bowel has been restored to normal size it is only necessary to use the dilator at infrequent intervals Following pull through operations strictures are more common but they respond well to digital dilatation and out of 24 such strictures quoted by Bacon (1956) only one needed to be divided but a colostomy was not required in two other cases a colostomy followed by resection of the stenosed bowel, was necessary

Preliminary Colostomy

For those patients requiring excision of the rectum but in whom there is no intestinal obstruction the question of a preliminary colostomy prior to a sphincter saving operation is discussed elsewhere in this volume Here it is sufficient to say that as a general rule surgeons are now carrying out anterior resections and pull through operations with careful pre operative preparation but only rarely with a preliminary colostomy unless there is intestinal obstruction The wisdom of this is borne out by the success of the operations and the rare occasions on which it is necessary to perform a secondary colostomy following leakage or infection at the suture line There are certain disadvantages in making a colostomy either before or at the same time as the anastomosis One of these is the obvious disadvantage of adding to an already major procedure and another is the need for closure of the colostomy when the anastomosis is established

Disturbance of Rectal Continence and Bowel Control

Anterior Resections

These patients always regain complete control of flatus and faeces whether fluid or solid In some of them the bowel action is more frequent than formerly

perhaps partly due to loss of water absorbing colon but partly from disturbance of the normal mechanism of defaecation Sometimes they do not seem to evacuate completely the left colon but rather to have repeated partial filling of the rectum, giving the desire to stool without achieving a full emptying of the bowel Although inconvenient, it is not incompatible with a normal life and is usually well tolerated by the patient

Pull through Operations

Before considering the degree of control following these operations it should be borne in mind that they include resection of growths down to 7 cm from the anal margin, whereas the majority of surgeons would perform an abdomino perineal excision at this level and reserve the anterior resection for growths above 10 cm from the anal verge In one of his recent publications Bacon (Bacon 1956) describes carefully and impartially the degree of control obtained from pull through operations A large proportion of the patients regain complete faecal control, that is to say they do not have to wear a pad and there is no soiling The most significant feature is the difficulty of attaining complete emptying of the colon and this is not surprising when one realizes that almost the whole of the rectum has been excised, taking with it the valuable sensory mechanism which contributes so much to normal defaecation These patients require careful post operative re education of their sphincter muscles and many months may elapse before their convalescence is complete Only 3 patients in the series of 431 described by Bacon wear a perineal pad But this is not the whole story as 61 per cent of the patients assist the evacuation of their bowels by irrigation or enemata varying between daily and weekly treatments The others are continent, with complete bowel movements without irrigation In Bacon s opinion this operation has given a high percentage of successes with good control with or without irrigation Unfortunately, in other hands the pull through operation has not given such good results and incomplete control has been more common

Abdominal Complications Common to Both Types of Operation

It is now accepted that radical operation for carcinoma of the rectum can not be performed without opening the abdomen, therefore it is not proposed to discuss the complications common to all abdominal operations but only those associated with excision of the rectum Post operative pulmonary and cardio vascular complications and disorders of renal function such as suppression and uraemia are therefore omitted

Peritonitis

In spite of the low morbidity attending excision of the rectum by modern methods peritonitis is still the most common cause of death particularly in sphincter saving operations This complication arises either from soiling at the time of the resection or, much more commonly from leakage at the suture line

Following major operations the symptoms and signs of peritonitis may be masked by post-operative shock and other factors The normal post operative convalescence with a little fever, perhaps associated with an open perineal wound may cause an inflammatory process within the abdomen to be over looked The abdominal pain might be the result of a urinary disturbance or a new colostomy which is still irregular in its action In other patients the indica tions may be clear cut and the peritonitis revealed by pain perhaps localised to the site of origin, but later generalized over the whole abdomen Vomiting is usually present at the outset and again later if the peritonitis is spreading Pulse rate shows a steady increase usually accompanied by fever but sometimes in an acute fulminating case the temperature becomes subnormal

Examination reveals that movement of the abdomen is restricted and bowel sounds reduced There is localized tenderness and rigidity and the bowels are constipated

Treatment is usually by operation but occasionally when localization can be expected conservative measures may be used In all cases intravenous drip infusion and aspiration of the stomach by Ryle s tube or if preferred suction on the small bowel (by Miller Abbott tube) is instituted with the appropriate chemotherapy Heat may be applied to the abdomen If there is any doubt as to the progress of the patient an immediate laparotomy should be performed Evacuation of an abscess may be necessary later on if the inflammation localizes

Of equal importance to the treatment is the prevention of peritonitis The accepted prophylactic measures include careful pre operative preparation of the bowel with one of the intestinal antiseptics such as sulphathalidine neomycin or guanimycin In cases of anterior resection an adequate blood supply to the proximal bowel must be preserved and all tension on the anastomosis avoided Most surgeons drain to the anastomosis either transperitoneally or extra peritoneally A sump drain with suction is one of the favoured methods Open tubes or corrugated rubber drains are also used

Intestinal Obstruction

Ileus

Whenever the peritoneal cavity is opened a temporary inhibition of intes tinal movement results from the trauma to the peritoneal sympathetic nerve endings The severity of the ileus is not necessarily related to the type of opera tion and the removal of a chronic appendix with a general exploration of the peritoneal cavity may be more distressing to the patient than a colectomy As a rule this post operative ileus is self correcting and responds to the routine measures that are employed for abdominal cases

Paralytic Ileus

This can be a severe condition following major abdominal operations It is usually kept at a minimum by prophylactic measures such as the avoidance

of traction upon mesenteries and parietes and the correction of blood loss during the operation

The diagnosis of ileus is made when, after 5 to 7 days no flatus has been passed there has been no response following an enema, of either faeces or flatus and when the abdomen is silent and slightly distended There is rarely abdominal pain, only a vague discomfort, without tenderness or guarding Gastric aspirations increase in volume and the pulse rate rises X ray examination of the abdomen may show distended coils and fluid levels

The post operative gastric aspiration and intravenous infusion should be continued If a colostomy is present a flatus tube may be passed or an enema administered at intervals, but if a low anastomosis has been made these measures are dangerous as they may disrupt the suture line Glycerine suppositories may initiate the first bowel action or drugs, such as acetyl choline or prostigmine may be effective In more severe cases various alternative measures have been used such as A procaine block of the abdominal wall (Milnes Walker), Oxygen inhalation to increase the oxygen content of the mesenteric blood (Bacon), the use of a Miller Abbott tube or even a jejunostomy

Mechanical Intestinal Obstruction

This may take the form of

1 Adhesions
2 Lateral space obstruction
3 Herniation behind an anterior resection, or through a newly formed peritoneal floor
4 Volvulus

Such complications are less frequent if raw surfaces in the new peritoneal floor have been avoided, if the lateral space has been closed after an intra peritoneal colostomy and if when an anterior resection has been performed, the colon has been sutured to the posterior abdominal wall to prevent internal herniation behind the anastomosis

The obstruction can be recognized by intermittent abdominal pain associated with frequent high pitched bowel sounds on auscultation Distension and vomiting are also present and may indicate the level of the lesion With a high obstruction vomiting is early and frequent but there is little distension whereas in a low obstruction the distension is early and very marked while vomiting only occurs in the late stages X ray examination may confirm the diagnosis and be helpful in locating the obstruction

In all such patients the post operative intravenous infusion and gastric suction with a Ryle s tube are continued If the patient is past this stage and has started taking drinks by mouth it is better to revert to the strict régime of nothing by mouth gastric suction and intravenous infusion of dextrose and saline If there is a possibility that the blood supply to the bowel is endangered as might be indicated by a localized tender mass and a rise in pulse rate an immediate laparotomy should be performed In most cases there is less urgency and occasionally an obstruction caused by oedema around an anastomosis

may be relieved without operation with the assistance of the routine treatment for ileus generally the laparotomy is necessary and should be performed when the patient s condition is at its optimum

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SECTION SEVEN

AN ANALYSIS OF THE RESULTS OF THE SURGICAL TREATMENT OF RECTAL CANCER AT ST MARK'S HOSPITAL

CHAPTER XXIII

RESULTS OF THE SURGICAL TREATMENT OF RECTAL CANCER

H J R Bussey C E Dukes
H E Lockhart-Mummery

THIS chapter deals with the general results o [illegible] l treatment of rectal cancer It is based largely on the exper [illegible] Mark s Hospital where for more than 30 years careful records have [illegible] the after history of a large series of surgically treated patients bu [illegible] are also made with the published results of other centres D [illegible] r od of 30 years included in this review there have of course bee [illegible] developments in the surgery of rectal cancer and we shall endeavo [illegible] hat effects these have had on 5 year survival rates Then lookin [illegible] o the future we shall discuss the foreseeable ways in which the [illegible] atment of rectal cancer might still further be improved

Definition of 'Rectum' and 'Cancer'

It will help to remove possible misunderstanding if we first define the way in which we are using the words rectum and cancer and also make some comments on the value and limitations of 5 year survival rates in such a disease as rectal cancer

As explained elsewhere in this Monograph no method has yet been devised for the exact definition of the different segments of the distal portion of the large bowel At St Mark s Hospital a growth has been regarded as being at the recto sigmoid junction when as disclosed at operation it was found to be level with the promontory of the sacrum after any retaining adhesions had been divided and the bowel gently straightened Any growth below that level has been regarded as a rectal tumour and any growth above that level has been classified as in the colon In the St Mark s records therefore recto sigmoid growths are regarded as arising in the rectum but no growth above that level has been included for analysis Included in the records also are adenocarcinomas arising from the lowest part of the rectum or upper anal canal because the exact lower boundary of the rectum is equally impossible of exact definition

In all cases included in this series the diagnosis of rectal cancer was based either on microscopic examination or on indisputable clinical evidence As far as microscopic diagnosis was concerned the only cases accepted as cancer were those in which the sections showed definite invasive carcinoma Cases which in some centres might be classified as carcinoma *in situ* or intramucosal carcinoma have not been entered as cases of cancer or included in this series In other words only cases of invasive adenocarcinoma of the rectum have been included

Comments on 5-year Survival-Rates

The present analysis is based very largely on 5 year survival rates Many of the patients in the St Mark s series have been under observation for much longer periods than this but since during the past thirty years there have been important changes in surgical technique, and especially because treatment by restorative resections was only resorted to frequently in the last decade it is simpler when making comparisons to use the same yardstick throughout It must be kept in mind however that by restricting comparisons to 5 year survival rates we can at the present time only reach conclusions which are tentative in character subject perhaps to revision when a larger number of cases have been kept under observation for a longer period of time

Another point to remember is that 5 year survival rates after surgical operations are usually based on operation survivors only This is perhaps the fairest way of comparing the rival claims of two different operations and the value of such comparisons is usually increased if corrections are also made for the expected *mortality from other causes during the 5 year period* This adjustment is advisable because some patients who failed to live for five years may have died of cancer and some from other causes but the crude 5 year survival rate makes no distinction between these The point becomes of special importance in relation to rectal cancer because the risk of dying from other causes increases just at the time of life when many patients receive surgical treatment

It might be possible in a small series of patients to ascertain the cause of death in each case but in a large series this method is impracticable and it is easier and probably more accurate to proceed indirectly and make allowance for intercurrent deaths by making use of data provided by life tables When a correction is made for the estimated probability of dying from causes other than cancer the term corrected survival rate is used There is more than one statistical device for producing a corrected survival rate and the method used in the St Mark s series is that recommended by Paterson Tod and Russell in their book *The Results of Radium and X Ray Therapy in Malignant Disease*

Finally we must recall a fact which may easily be overlooked namely that although corrected 5 year survival rates are reliable for comparison of different forms of treatment they may fail to give a true picture of what is achieved by surgery because they take no account of operability or operative mortality rates

Without information with regard to operability rates and operation mortality figures it is difficult to make comparisons between the published records of different hospitals For example two hospitals X and Y each record a 5 year survival rate of 40 per cent after surgical treatment of rectal cancer but at X 90 per cent of all patients diagnosed as suffering from cancer were treated surgically whereas at Y only 50 per cent of patients were accepted for operation Although the 5 year survival rate (based on operation survivors) may be the same at each hospital it is obvious that hospital X with its operability rate of 90 per cent is achieving much more than the more cautious hospital Y with its operability rate of only 50 per cent

General Results of the Surgical Treatment of Rectal Cancer at St Mark's Hospital (1928–57)

Between the years 1928 and 1957 inclusive a total of 4 435 cases of primary carcinoma of the rectum or recto sigmoid were seen at St Mark s Hospital

Two hundred and forty nine of these have been excluded because for one reason or another they were not assessed for treatment but the remaining 4,186 patients were fully investigated with a view to surgical treatment if this seemed in any way to be indicated 3 204 of these were eventually treated by a major surgical operation which removed the primary tumour and all patients in whom the primary tumour was removed surgically have been further subdivided into two groups according to whether the operation was regarded as radical (2 787 cases) or as palliative (417 cases) A rigid definition of these two terms has been adhered to throughout When at the time of the operation in the opinion of the surgeon all known growth had been removed the operation was classified as radical but if at the time of operation it seemed certain that growth had been left behind either locally or as distant metastases then the operation was recorded as palliative

A summary of the classification of all cases of rectal cancer seen at St Mark s in the years 1928–57 is given in Table XX and represented graphically in Figure 77 These provide an overall picture of the whole 30 years under review

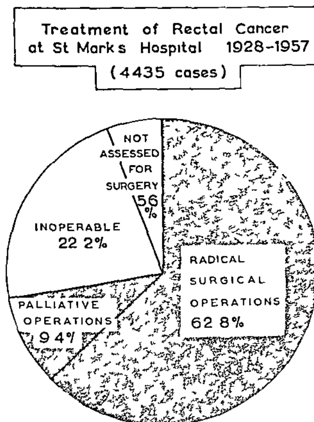


FIG 77

TABLE XX

Treatment of Rectal Cancer at St Mark's Hospital (1928–57)
(4,435 *cases*)

	Number	*Percentage*
Radical Surgical Operations	2787	62.8
Palliative Operations	417	9.4
Inoperable	982	22.2
Not assessed for surgery	249	5.6

Five-year Survival rates of 'Operable' Cases

In reporting the 5 year survival rates of those patients in whom the primary tumour was removed surgically we shall confine the analysis to the period 1928–52 so that all patients included may have been under observation for at least 5 years

During this 25 year period 2,446 patients were treated surgically in this way Two thousand two hundred and sixteen survived the operation and the crude 5 year survival rate of these was 48.3 per cent, and the corrected' 5 year survival rate was 57.2 per cent

Two thousand one hundred and sixty three of these operations were classified as 'radical and 283 as 'palliative The crude 5 year survival rate of the radical cases was 53.2 per cent and the corrected rate 63.0 per cent On the other hand the crude 5 year survival rate of the palliative cases was only 11.6 per cent and the corrected rate 13.7 per cent

TABLE XXI

Five-year Survival Rates of Patients in whom the Primary Tumour was Removed Surgically at St Mark s Hospital (1928–52)

	Total cases	*Operation survivors*	*5 year survival rate* Crude (*per cent*)	Corrected (*per cent*)
RADICAL				
Males	1415	1261	52.5	63.8
Females	748	697	54.4	61.7
Total	2163	1958	53.2	63.0
PALLIATIVE				
Males	203	186	13.4	16.1
Females	80	72	6.9	7.8
Total	283	258	11.6	13.7
Total males	1618	1447	47.5	57.6
Total females	828	769	49.9	56.6
GRAND TOTAL	2446	2216	48.3	57.2

Analysis of 'Operable' Cases

The term Operable Cases' is used to describe all p[illegible] who underwe[illegible] an excision of the primary tumour either as a radical [illegible] a palliati[illegible] measure Some operations were used only rarely at St [illegible] Hospital an[illegible] even in a 30-year period the total number of cases so [illegible] too small t[illegible] warrant any separate analysis For example a few ver[illegible] [illegible]ions includin[illegible] some benign tumours with evidence of early malignant [illegible] were treated b[illegible] purely local excision A small number of Hartmann's [illegible] were carried out and also a number of abdomino anal operation [illegible] [illegible]unsell Wei[illegible] method A few further patients were treated by operat[illegible] [illegible] the whol[illegible] colon as well as the rectum (for example in cases of rec[illegible] [illegible] accompanied by multiple polyposis or ulcerative colitis) or by operat[illegible] to remove other viscera besides the rectum such as pelvic clearance but th[illegible] form a very small number and warrant no separate statistical analysis

The great majority of patients were treated by standard operations for the removal of rectal cancer In the early years of this survey mos operable rectal cancers were removed by the two stage perineal excision (Lockhart Mummer 1920) the abdomino perineal operation (Miles 1908) being occasionally [illegible] for growths high in the rectum In 1932 the perineo abdominal operation [illegible] one stage was first described (Gabriel 1932) and gradually came to replace the two-stage perineal and the abdomino perineal operations in the practice of the surgeons of St Mark s In 1939 the synchronous combined operation was introduced (Lloyd Davies 1939) and within a few years became the most fre quently performed operation in the practice of many of the surgeons During the years before the war operations with restoration of continuity were practised only occasionally, but in 1947 and 1948 the operation of anterior resection was gradually introduced and has now become an accepted procedure in the treat ment of suitable growths

Quite apart from anatomical or pathological considerations which influence the selection of operation, the personal choice skill and experience of the indi vidual surgeon has naturally played a major part in the choice of operation The main reason why the Miles abdomino perineal operation has never been extensively used at this hospital is because the surgeons at St Mark s have usually been more familiar with other techniques and have preferred to continue to practise them though it is recognized that this pioneer combined operation is more widely practised throughout the world than any other method of excision of the rectum

These four operations namely perineal excision perineo abdominal exci sion synchronous combined excision and anterior (restorative) resection have, then been the four operations most usually undertaken for the treatment of rectal cancer 2 904 of the total 3 204 patients were treated surgically by one of these four operations

Each of these four operations will now be considered more in detail

operation of anterior resection Not only was the growth in the upper rectum or recto sigmoid but it was considered to be relatively favourable from a patho logical aspect In other words early and less advanced growths were treated by anterior resection, rather more advanced growths were often treated by a form of combined excision Hence, in this group there were more A cases and fewer C cases, and it would be wrong to assume from this evidence that anterior resection is a better operation than combined excision for any particular tumour However, Mayo and Fly (1956) Mayo *et al* (1958) Best and Rasmussen (1957) Bacon (1956) and Waugh *et al* (1955) have all published series of sphincter saving operations in the treatment of rectal cancer and compared their results with combined excision for growths at the same level All these authors claim that sphincter preserving operations are as effective in the treatment of rectal cancer at all levels as combined excision Mayo and Fly (1956) also state that their results appear to show no significant differences in 5 year survival according to the level of the lesion in relation to the peritoneal reflection

Comparison with Other Centres

We shall not attempt to make detailed comparisons of these results with those of other centres because of differences in time, place, selection of cases and manner of presentation of statistics but in general the St Mark s figures do not differ much from those published by Coller *et al* (1952) Grinnell (1953) Daland and Michell (1953), Kratzer (1953) Finsterer (1954) Spear and Brainard (1951) Waugh *et al* (1955) D Allaines (1956) Swinton (1956) Ottenheimer and Oughterson (1955) Delannoy *et al* (1954) Sadler and McSwain (1955) Rowe and Williford (1955) Muir (1956) Mayo and Fly (1956), Swinton and Counts (1956) Coffe and Vigoni (1957) Postlethwait *et al* (1958)

Most of these authors have been working at hospitals which have taken a particular interest in rectal cancer where the surgical staff has acquired special experience in the treatment of this disease Their results are certainly much better than could be expected in hospitals where rectal cancer is rarely treated surgically

So it might be fair to sum up the modern surgical treatment of rectal cancer by saying that the best results which can be expected at the present time are in general terms somewhat as follows If the operation is carried out on patients in whom there is still a reasonable prospect of cure between 40 and 60 per cent of the operation survivors are likely still to be alive five years later Some of those who have survived for five years may eventually succumb to a recurrence but the majority of 5 year survivors are likely to be cured

CHANGES AND IMPROVEMENTS IN THE PERIOD UNDER REVIEW

There have been great advances in the surgery of rectal cancer in the last 30 years As in other branches of surgery these have reflected the general improvements in surgical technique anaesthesia and supportive therapy that have occurred during this time, and have resulted in an increase in the scope and a reduction in the risk of the surgery of rectal cancer

The increase in the scope of surgery is shown most simply by comparing the average age of patients in the St Mark s series in the first and last 5 year periods In 1928-32 the average age of those submitted to surgery was 57 9 years and in the last 5 year period it had increased to 62 4 years

A second important change the increase in the resectability rate is shown graphically in Figure 78 This shows that the resectability rate was only 46 6 per cent in the first 5 year period and in only 2 3 per cent was a palliative resection done (that is removal of the primary tumour in the presence of irremovable metastases and therefore without hope of perman n cure) Since then the resectability rate has steadily increased particularly so in the last 10 years, and has now reached the high figure of 93 1 per cent Some but not by any means all of this increased resectability has been due to an increase in the number of palliative operations The main reason for this remarkable increase in resectability rate is a gradual change of policy towards r ctal cancer so that nowadays surgeons attempt to remove the primary tumour whenever possible in order to spare the patient the discomfort and ill health due to the presence of the growth in the rectum

A third important change in the 30 years under review has been the progressive decline in operative mortality In the first quinquennial period (1928–32) the operative mortality was 10 2 per cent but in the last (1953–57) it had fallen to 3 8 per cent

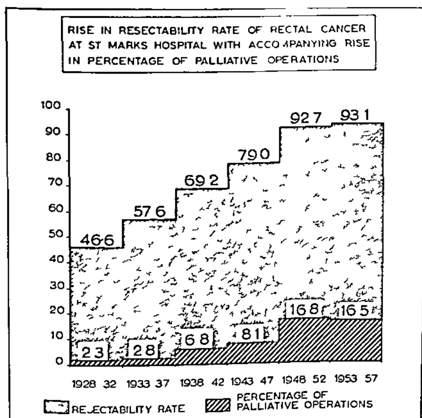


FIG 78

TABLE XXII

Operative Mortality of Rectal Cancer
St Mark s Hospital, 1928–57

Period	*Number of operations (removing primary tumour)*	*Number of deaths*	*Operative mortality (per cent)*
1928–32	226	23	10 2
1933–37	346	45	13 0
1938–42	408	50	12 1
1943–47	615	53	8 7
1948–52	851	59	6 9
1953–57	758	29	3 8
Total	3204	259	8 1

This is indeed a notable surgical triumph The average age of patients submitted to operation has risen and more and more advanced cases have been accepted for operation and yet in spite of this the operative mortality has declined A steadily increasing resectability rate might have been expected to adversely affect the operative mortality rate because of a lowering of the general standard of fitness for operation but the opposite has happened and the operative mortality has continued to decline

The change of policy towards rectal cancer which has resulted in an increase in the proportion of cases submitted to surgical treatment and a corresponding decrease in those regarded as inoperable is illustrated in a convincing way by comparing the first and last 5 year period included in this review, as represented graphically in Figure 79

Perhaps the best way of recording the progress made in the surgical treatment of rectal cancer during this 30 year period is to compare the fate of a group of rectal cancer patients admitted to hospital in the first 5 year period (1928–32) with that of a similar number admitted in the last period (1953–57)

If such a group of 100 patients had been admitted during the first 5 year period it might be expected that 41 8 per cent would have been treated by radical operations and 2 1 per cent by palliative a total of 43 9 per cent On the other hand in the last 5 year period 74 2 per cent of patients were treated by radical operations and 16 per cent by palliative a total of 90 2 per cent In both the first and last 5 year periods the crude 5 year survival rate was just under 50 per cent and if this rate is applied to the 43 9 per cent treated surgically in the first 5 year period and to the 90 2 per cent treated surgically in the last 5 year period we reach the conclusion that twice as many patients in the period 1953–57 lived

to celebrate the fifth anniversary of their admission to hospital as in the initial period 1928–32

These comparisons are represented graphically in Figure 80 They are only approximate estimates but the important point is that they show that in the last 5 year period there were approximately twice as many 5 year survivors as in the first period This is the simplest and most convincing way of expressing the progress made in the surgical treatment of rectal cancer during the course of these 30 years

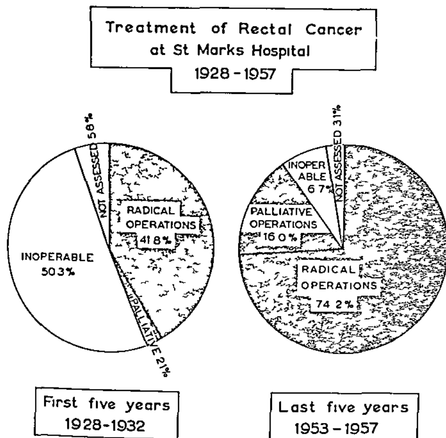


FIG 79

POSSIBILITIES FOR FUTURE

Looking forward into the future it is natural to ask if the progress of the past 30 years will still continue or whether the surgical treatment of rectal cancer will now reach a stationary phase

Before hazarding an answer to this question we should first recall that in the period under review the improvement in the overall results of the surgical treatment of rectal cancer has been due to three main causes The first and most important has been the rise in the resectability rate and consequent decline in

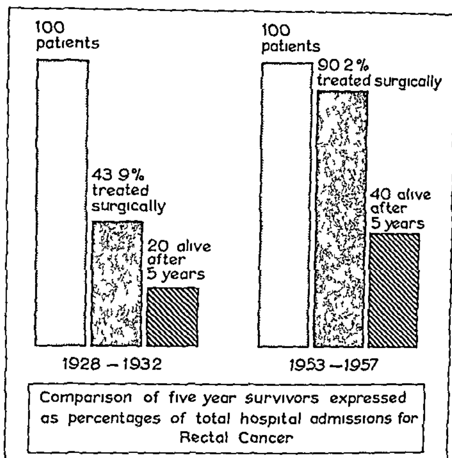


Fig 80

the proportion of cases regarded as inoperable but not much more improvement can be expected from this source in the future since the current resectability rate is now over 90 per cent

The second major cause of improvement in results has been the more general adoption of combined excision and other measures for the widest possible removal of the field of lymphatic spread, but it seems unlikely that further developments along these lines by yet further enlarging the field of surgery will have much effect on 5 year survival rates

A third notable advance in the period under review has been the steady decline in operation mortality (as recorded in Table XXIII) but even if this should continue still further this alone can only be expected to make a small contribution to improvement in the overall results of the treatment of rectal cancer in the future

If further progress is to be made in the future we must begin to look in other directions and here perhaps pathology may point the way because the examination and classification of operation specimens of rectal cancer has provided overwhelming evidence that the end results of the surgical treatment of rectal cancer depend to a great extent on the stage of the disease at the time of operation

TABLE XXIII

5 year Survival Rate of A B and C Cases
(Operation survivors)

	Number of cases	Survival rate	
		Crud (per cent)	Corrected (per cent)
A	308	81 2	97 7
B	692	64·0	77 6
C	1037	27 4	32 0
Total	2037	48 3	57 4

This question is discussed more fully in Chapter VI and here we will only recall that the figures recorded in Table XXIII show that the crude 5 year survival rate is 81 2 per cent for patients operated on whilst the growth is still limited to the rectum (A cases) It is 64 per cent when there is local spread but no lymphatic metastases (B cases) but only 27 4 per cent for cases which have metastasized to the lymph nodes (C cases)

The lesson to be learnt from this is that the best hope for improvement in the results of the surgical treatment of rectal cancer in the immediate future lies in earlier diagnosis and earlier surgical treatment

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APPENDIX I

SUPPLEMENTARY INFORMATION ABOUT MORTALITY FROM CANCER OF THE RECTUM

R A M CASE

THE presentation of the statistical background to cancer (or any other) mortality to a diverse body of largely medical readers is a problem in itself This Appendix is therefore devoted to a discussion of some aspects of vital statistics for the benefit of those who without it might find Section One a little obscure The Appendix really consists of four more or less unconnected essays on background topics which are not essential to the development of the main theme of Section One (p 1) but which must be understood in order to follow the argument Some of the views expressed may be considered unorthodox and for this reason are discussed in detail

1 SOME OBSERVATIONS ON MORTALITY INDICES AND POPULATION ESTIMATES

Various simple arithmetical procedures can be applied to population and death data to produce a battery of mortality indices but one index may be more appropriate than another in a particular set of circumstances

Let us first consider what type of statement can be made by a mortality index Broadly speaking we may distinguish between what I shall call the *administrative* and what I shall call the *biological* statement Either type of statement may be legitimate if it is appropriate to the question either type may become illegitimate when inappropriate

As an example of the administrative question let us consider the case of a maker of coffins who has just set up in business He will wish to know how many coffins he may expect to have to make in a year, and the simple ratio

$$\frac{\text{Number of deaths in England and Wales (D)}}{\text{Population of England and Wales (P)}} \times \begin{array}{c}\text{Number of people}\\ \text{in his area}\end{array}$$

for the previous year may satisfy him The first part of this ratio $\frac{D}{P}$ is called the crude death rate A comparison of a series of crude death rates for different dates should not however be used to answer the enquiry Has the impact of killing disease on the community lessened in the last twenty years? since although the crude death rate (male) *rose* from 12 9 per 1 000 for the decade 1921–30 to 13 0 in the next decade and fell to 12 5 in the decade 1941–50 a *considerable reduction* of the impact has in fact taken place A consideration of the frequency with which death occurs at different ages will at once suggest an explanation of this paradox Death is about ten times as frequent between the ages of 55 and 60 as it is between the ages of 20 and 25 For this reason an alteration in the age composition of the population alone

may alter the crude death rate very considerably although the impact of killing disease on the community may not have changed

The most important step in refining a crude mortality index is the calculation of age specific death rates distinguished by sex The estimated population and the deaths are put into similar age groupings and each death rate is calculated separately for each age group Age specific rates form the basis for most refined mortality indices

It is desirable at this stage to consider what sort of statement is made by a mid year estimate of population by age groups In any age group a considerable proportion of its members will live throughout the calendar year but deaths will occur throughout the whole year Some members will die in the first half of the year and others will live into the second half of the year but die before the end of the calendar year The number of deaths that occurs in the first six months of the calendar year is for any age group in England and Wales at least, very nearly the same as the number that occurs in the second six months of the year Without resorting to formal proof we may take it that the mid year estimate of the population for a particular age group can be accepted as a good estimate of the number of years of life lived in the calendar year in question by a group of people of the stated age passing through the whole year This important proposition holds true to well within the limits of error in forming the estimate although it could be disturbed by violent epidemics catastrophes or mass migration

We can now see why the age specific death rate is a measure of the intensity of the impact of a killing disease on a community of a stated age If we visualize mortality as a threat of death varying in intensity at different ages that hangs over a population we can measure the intensity of the threat at a particular age by allowing it to act on a number of individuals of the relevant age for a measured time and then counting the dead This is strictly analogous to the situation referred to by an age specific death rate *The rate is expressed as the number of deaths occurring per unit* number (we shall most frequently use 1 000 in this Appendix and in Section One) of years of life lived by a group of persons whose ages lie between specified limits By convention this is written as the age specific death rate per 1 000 living per year

The procedure of forming age groups eliminates to a large extent the effect of the actual age of each individual by narrowing the age range to a point where the variation of the actual ages becomes relatively unimportant The members of the age group may differ in respect of many attributes other than age that render them more or less susceptible to the lethal force but since we cannot measure these attributes we cannot take them into account in the calculations It is however legitimate to construe the age specific death rate as an estimate* of the average chance of dying

* Formally the measure of the chance of dying within one year after attaining the exact age x is the life table death rate q_x given approximately by the expression $\frac{D}{P+\frac{1}{2}D}$ where P refers to the mid year estimate for the age group x to $x + 1$ years and D is all deaths in that age group during the year In our discussion this difference between the two types of death rate is not relevant to the argument when we are referring to the *mortality from all causes*

When dealing with the age specific disease specific death rate however the death rate for the age group x to $x + 1$ is obtained from the expression $\frac{d}{P}$ where d is the number of deaths from the disease under consideration and the life table disease-specific death rate from $\frac{d}{P+\frac{1}{2}D}$ In our discussion therefore we can regard the age specific disease specific death rate as in the sense given above an estimate of the chance of dying from the disease under consideration within a stated time (here one year) *if no other fatal disease intervenes*

within a specified unit of time (here one year) for all the individuals in the population under consideration whose ages lie within the limits prescribed by the age group If it is conceded that it is legitimate to refer to the death rate as the *average* chance of all the members of the age group it follows that it can also be used in the sense that it is the *average* chance referrable to each member of the age group although the *specific* individual chance is incalculable because of the lack of information about attributes other than age

Both the crude death rate (male and female) and the age specific death rate may be further differentiated into disease specific rates by using the number of deaths classified by disease instead of the total deaths from all causes although as the number of deaths in each subdivision gets smaller the chance of sampling errors in the estimate will increase and it may become necessary to combine the data into year groups say quinquennial or decennial as well as age groups It is useful to have both the year and age groups of the same size

Since the age specific death rate from all causes is the sum of the disease specific death rates for that age group a change in one disease specific death rate need not affect any other disease specific death rate but only the total of the rates (the death rate for all causes) There may sometimes be biological reasons due to synergism or repulsion between particular diseases which would cause a reciprocal alteration of disease specific death rates but there is no constraint due to the calculation of the rate that prevents their being independent

2 THE CONCEPT OF COHORT ANALYSIS AND ITS PLACE IN GAINING AN UNDERSTANDING OF A CONTEMPORARY ARRAY OF DEATH RATES

I have given a fairly complete account of cohort analysis of death rates as a narrative technique elsewhere (Case 1956) In what follows I propose to discuss how an understanding of this method of analysis can help us in understanding the meaning of a contemporary array of death rates

A contemporary array of death rates has been defined (p 3) as the series of age specific death rates relating to a given date and an example of a series of such contemporary arrays is found in Tables I and II (pp 3 and 4) where the mortality data for cancer of the rectum in England and Wales are set out in a form suitable for cohort analysis

When we consider the figures shown in Tables I and II and start at the top left hand corner (age 0–4 date 1911–15) we have an age specific death rate referable to a group of people born around 1911 (For exact details of how the group is derived see Case (1956)) It is obvious that the age specific death rate for the survivors of this group when they are in the age group 5–9 is found not under the date 1911–15 but under the date 1916–20 and so on diagonally across each Table

If we now draw the contemporary age specific array for the date 1951–55 in the conventional manner we can understand that each column is the age specific death rate of the survivors of a group whose antecedent age specific death rates fall along a line running back into the past and are not represented by any of the columns of the conventional representation

This can be illustrated as follows from simplified data Suppose that we start with this imaginary contemporary age specific death rate array for 1951–55 —

Age (years)	*Death rate per 1 000 living per year*
30–	17 0
40–	21 5
50–	30 2
60–	40 0
70–79	31 7

In terms of the conventional representation of age specific death rates this would appear as in Figure 81 Each black panel represents the 1951–55 age specific death rate for the appropriate age group There is a tendency for the eye to run along the black panels and imagine that they form a series in the sense that one is the antecedent of the next as we progress up the age scale

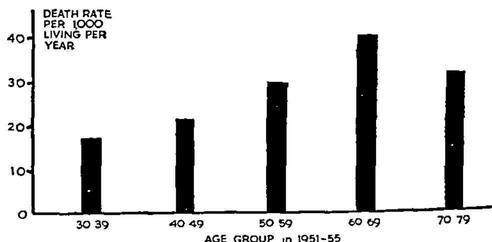


FIG 81

The age sp cific death rates for a given date (here 1951–55) presented in the conventional manner The columns are spaced more widely apart than is usual (From imaginary data)

If we now consult Figure 82 where the black panels are identical with those of the conventional representation we see that each black panel is in fact the latest of a series of panels (shown chequered) which represent the mortality of the particular cohort at different dates (and hence at different ages) in time past A cohort is a group of people born during a specified period and is referred to by the central date of that period *e g* the 1918–19 cohort were the people born around 1918–19

This representation makes it plain that no black panel can ever be in sequential series with any other black panel and that the shape of the series suggested by the black panels may be very different from the shape of any of the series of antecedent chequered panels

When we are dealing with any disease the mortality rate of which is to any extent influenced by nurture (and this includes a large proportion of all diseases) the difference between the series of chequered panels leading up to the contemporary black panel and the series suggested by the black panels alone may become very

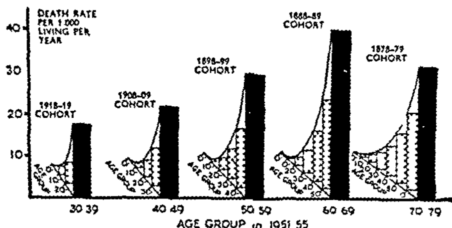


Fig 82

The cohort analysis background to the conventional representation of th- age specific death rates for 1951-55 The black panels are identical with those of Figure 81 and the death rate scale refers only to these 1951-55 rates The chequ red panels represent the death rates in ten year ag- groups of the survivors of cohorts born around the dates shown (From imaginary data)

marked Since only the chequered panels (which are often perforce unrepresented) are relevant to the way in which the rate represented by the black panel has evolved a good knowledge of the social and medical history of the past is clearly necessary before attempting to interpret a contemporary mortality pattern

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3 A Note on Age standardized Summarizing Indices

A summarizing index is a single figure which emphasizes one particular aspect of a situation which has been described in statistical terms and before deciding to employ such an index it is essential to have a clear understanding of the nature of the statement made by the index to be used A survey of the current fashions of usage of summarizing indices far from giving a clear impression of the issues which should be considered before undertaking such an analysis might in fact suggest that some one procedure is able to bring all the relevant features of a situation into perspective

This generalization is particularly relevant to a class of indices widely used in the study of mortality rates and known as age standardized summarizing indices They may take the form of numbers rates or ratios and the ones which are relevant to our subject are the expected number of deaths the age standardized death rate and the age standardized mortality ratio

Numbers

One of two concepts that of the expected number of deaths and that of its corollary the observed number of deaths is common to all these indices

The Expected Number of Deaths can be defined as the *number of deaths that* would be expected to occur in a defined population in a stated time if certain specified conditions were fulfilled In order that this *number may be calculated it is necessary* to have —

(i) *A statement of the* age specific death rates that are assumed to be operating

and (ii) A definition of the population which includes a statement of the *number of* years of life lived by its members in the age groups to which the age specific death rates refer (As we have already seen (p 282) the mid year estimates of population in age groups give this information for each calendar year of the stated period) The population defined in this way may be an actual or an hypothetical one

(The worked Example (pp 288–9) of calculating summarizing indices shows such information in columns 1–6)

The expected *number of deaths is arrived at by the addition of the results of* multiplying each age specific death rate by the number of years of life lived by the *population of that age group in the stated period* (*See columns 9 10 12* and 13 of Example)

The 'Observed Number of Deaths is simply the total number of deaths that did in fact occur *in an actual defined population in a stated time* Clearly our knowledge of this *number is not dependent* on prior knowledge of the age structure of the population or of the age specific death rates that actually obtained (See columns 2 and 5 of Example) *It is also clear* that if the population used above for the calculation of an expected number of deaths is an actual and not an hypothetical population it will give rise also to an observed number of deaths

Rates

By dividing by the *total number of years of life lived by the defined population* in the stated period of time both the expected and the observed number of deaths may be converted into a rate *which can be expressed in any convenient unit* e g death rate per 1,000 living per year

Crude Death Rate

From what has been said on page 281, we can see that the observed number *of deaths when expressed in this way gives the crude death rate of the population* (See columns 2 and 5 of Example)

Age standardized Death Rate

The rate produced by the division of the expected number by the defined *population is known as the* age standardized death rate (See columns 9 10 12 and 13 of Example) The statement made by this rate can now be seen to be 'This is *what the crude death rate for the population would have been* if some other specified set of age specific death rates had been operating and *falls* with the *crude death rate into what has previously (p 281) been called* the administrative class of statement

The defined *population* if it is an actual population can obviously give rise to *only one observed number of* deaths and to only one *crude death rate* Any defined *population however whether real or hypothetical* can be used as a base for the calculation of an unlimited series of 'expected numbers and age standardized death rates by the use of different sets of age specific mortality rates

Ratios

For purposes of comparison the numbers and rates described may be expressed as ratios for example —

$$\frac{\text{Expected number}}{\text{Observed number}}\left(\text{or } \frac{\text{Age standardized Death Rate}}{\text{Crude Death Rate}}\right) \text{ for a defined population}$$

or in the case of two expected numbers derived from two sets of age specific death rates (X and Y) acting on one defined population —

$$\frac{\text{Expected number from X}}{\text{Expected number from Y}}\left(\text{or } \frac{\text{Age standardized Death Rate from X}}{\text{Age standardized Death Rate from Y}}\right)$$

These may be left as simple ratios or as in the *Standardized Mortality Ratio* may be expressed as a percentage when equality is indicated by 100

Each of these ratios derived as they are from observed and/or expected numbers of deaths in a defined population describes the interaction of one defined population with each of two sets of age specific death rates The value of such a ratio will clearly depend on the age distribution of the chosen population the effect of the age specific death rate corresponding to a large age group in the population will be emphasized whereas a small age group will diminish the effect of the corresponding age specific death rate This type of summarizing index provides therefore no absolute comparison between two sets of rates and for any two given sets of age specific death rates the ratio obtained may well vary according to the base population chosen

The ratio type of summarizing index will remain constant whatever the base population in only one set of circumstances that the mortality pattern for a particular disease is irrevocably determined at birth and for any population this pattern is accurately reflected in the contemporary array of age specific death rates even though the intensity of the lethal force may vary from population to population If a changing environment or a changing genetic inheritance plays any part in determining the mortality pattern the contemporary array of age specific mortality rates will not show an unchanging shape as we have learned from cohort analysis (p 283)

The method of derivation of examples of these indices and a comparison of the statements made by them is shown in the Example (pp 288–9) Two imaginary countries A and B are used in this analysis and the mid year populations are shown in columns 1 and 4 Country A has hitherto been an under developed country The population has not been healthy famine has been rife and the care of the elderly whose constitution has been undermined by these circumstances has been poor Recently the country has been devastated by war and the population between the ages of 15 and 50 sadly depleted As a consequence the population figures taper off very rapidly with advancing age Country B on the other hand has not suffered such disadvantages Its climate is in general healthy its food production adequate its physicians skilled its statesmen wise and its neighbours peaceful This has resulted in a low mortality amongst the elderly and a happy immunity from catastrophic depletion of the young adults As a consequence the numbers in the population taper off relatively slowly with advancing age

The deaths per year from an imaginary disease X are shown in columns 2 and 5 Disease X is one with a marked environmental element in its aetiology and has a long and variable latent period between the application of the environmental stimulus and the appearance of the disease In country A the environmental factors which cause the disease have been much in evidence only during the last 40 years In country B

'e standardized Summarizing Indices for Mortality from Disease X in fferent Base Populations

ypothetical population	*Standardized on population of country A*		*Standardized on population of country B*		*Standardized on hypothetical population*	
7 *Sum of opulations A and B in thousands Cols 1+4)*	8 *Number of deaths per year at A rates (Σ Col 2)*	9 *Number of deaths per year at B rates (Col 1 × Col 6)*	10 *Number of deaths per year at A rates (Col 4 × Col 3)*	11 *Number of deaths per year at B rates (Σ Col 5)*	12 *Number of deaths per year at A rates (Col 7 × Col 3)*	13 *Number of deaths per year at B rates (Col 7 × Col 6)*
20 000		300 0	560 0		1 120 0	600 0
18 500		135 0	190 0		370 0	277 5
15 000		120 0	360 0		600 0	300 0
12 800		100 0	440 0		640 0	320 0
11 500		90 0	510 0		690 0	345 0
9 000		50 0	560 0		630 0	450 0
7 500		75 0	630 0		675 0	1 125 0
5 100		30 0	750 0		765 0	1 530 0
1 032		24 9	250 0		257 5	800 0
100 432	1 498	974 9	4 250 0	4 824	5 747 5	5 747 5
	1 498	—	—	4 824	—	—
	—	974 9	4 250 0	—	5 747 5	5 747 5
	0 045 (From Col 2)	—	—	0 072 (From Col 5)	—	—
	—	0 028 $\left(\frac{\Sigma \text{ Col } 9}{\Sigma \text{ Col } 1}\right)$	0 064 $\left(\frac{\Sigma \text{ Col } 10}{\Sigma \text{ Col } 4}\right)$	—	0 057 $\left(\frac{\Sigma \text{ Col } 12}{\Sigma \text{ Col } 7}\right)$	0 057 $\left(\frac{\Sigma \text{ Col } 13}{\Sigma \text{ Col } 7}\right)$
	100 (Base)	61 7 $\left(\frac{\Sigma \text{ Col } 9}{\Sigma \text{ Col } 8}\right)$	88 1 $\left(\frac{\Sigma \text{ Col } 10}{\Sigma \text{ Col } 11}\right)$	100 (Base)	100 $\left(\frac{\Sigma \text{ Col } 12}{\Sigma \text{ Col } 13}\right)$	100 $\left(\frac{\Sigma \text{ Col } 13}{\Sigma \text{ Col } 12}\right)$

Relative intensity of lethal force of death rates for countries A and B	*Measure of difference*
A rates > B rates	B = 0 62 A
B rates > A rates	B = 1 14 A
A rates = B rates	B = 1 00 A

they used to be widespread but were to some extent controlled between 40 and 50 years ago and have been kept under control since then As a consequence those under 50 years of age in country A have a relatively high mortality whilst those over 50 are less severely affected The young men in country B never lived through times when the environmental influence was very marked and so have a relatively low mortality rate whilst the older people, who have been exposed to the risk show a high rate of mortality

The differences between the age structures of the populations of the two countries and the differences between the age specific death rates from the disease X in the two countries as we have just seen, have been caused by two different and largely unconnected sets of circumstances In order to forestall a possible criticism that the hypothetical figures used show an extreme and unlikely difference I quote the explicit view of the Registrar General (1940) as to the nature of a standardized death rate He writes Standardized death rates are attempts to express the mortality of a population of *changing* or *abnormal* age distribution by a single figure calculated in such a way that the changes or abnormalities in constitution do not appreciably affect it (Italics inserted)

The question we are considering is how far any of the summarizing indices used can in a *concise form* give us useful information as to whether the lethal power of disease X is greater or less in country A than in country B and by how much The words *concise form* are used because an examination of the age specific death rates (calculated from the numbers of deaths and the populations and shown in columns 3 and 6) which are prerequisites to the calculation of the summarizing indices already tells us that disease X shows a higher death rate in the young in country A than in country B but that after the age of 50 the death rate is higher in country B The measure of the difference at any particular age is of course found in the age specific death rates themselves

From the populations and age specific death rates set out in the Example we can calculate three sets of indices —

(1) *Standardization on Population A* is demonstrated in columns 8 and 9 which show the result of the operation of the age specific death rates for countries A and B on a population whose structure is the same as that of country A

(2) *Standardization on Population B* where the two sets of age specific death rates are assumed to be operating on a population of structure the same as the population of country B is shown in columns 10 and 11

(3) *Standardization on an Hypothetical Population*

Many types of hypothetical populations have been proposed for use in age standardizing procedures From 1901 to 1940 the Registrar General used a population known as the Standard Million which had the age distribution of persons of undistinguished sex in the general population of England and Wales in 1901 (Registrar General 1940) Other authors have used the population of their own country in a particular year (e g Segi Fujisaku and Kurihara 1957) or have attempted to form a synthetic population by adding together figures relating to a large number of countries (e g Segi 1957) Another form of composite hypothetical population was proposed by the Registrar General (1945) when he introduced the Comparative Mortality Index a special form of standardized mortality ratio This population was a population whose percentage age distribution was made up of the mean of the percentage age distributions of the two populations which had

generated the two series of age specific death rates that it was desired to compare

In the worked Example (columns 12 and 13) the chosen hypothetical population is made up of the sum of the numbers in each age group of the populations of countries A and B This type of hypothetical population is essentially that proposed by Segi (1957)

The standardized death rate and the standardized mortality ratio have been calculated in all these cases and are shown in the Example

An examination of the results obtained (Terminal Statements Example) will show that the summarizing indices calculated are not unanimous in deciding whether or not the lethal force of disease X is greater or less in country A than in country B As was anticipated the result varies according to the base population used and none of the summarizing indices provides an absolute comparison between the two sets of age specific death rates

In short age standardized summarizing indices may not be able to help in answering *biological* questions about disease X but may contrive only to obscure the information far more precisely and usefully conveyed by the contemporary arrays of age specific death rates themselves

The Use of Indices

Having considered the limitations of summarizing indices it is now pertinent for us to inquire what useful information may legimately be gained from them

Take the case of an observed number of deaths and an expected number based upon some hypothesis both derived from the same defined real population There are two possibilities —

The observed and expected numbers may be sufficiently different for it to be inferred that the observed number could not have resulted from the operation of the set of age specific death rates specified by the hypothesis

or The observed and expected numbers may not differ sufficiently to justify such an inference

In the latter case we must reserve judgment Since it is possible for the same expected number to result from the operation of two or more different sets of age specific death rates (Example columns 12 and 13) we must refrain even though the observed and expected numbers are *exactly* the same from inferring that the particular set of age specific rates specified in the hypothesis has been operating

In what circumstances may the information to be derived from such a situation prove useful? As we saw earlier the observed number may be known without prior knowledge of the age specific death rates that have been operating If we have sufficient information to calculate such rates we can by direct inspection of them and of the age specific rates specified by any hypothesis we wish to test obtain more information than we should have done by the use of a summarizing index In circumstances where it is not possible to calculate the actual age specific death rates operating the use of a summarizing index may or may not prove useful

Imagine for example that we are comparing the mortality from a given disease in two different countries for only one of which we know the age specific death rates The discovery in such a case that the two sets of age specific rates in operation could not be the same would not be surprising nor would such information be of much benefit to us

Suppose however that of the two populations under consideration one is a

sub section of the other and can be regarded apart from the attribute or attributes which allow it to be defined as a sub section as representative of the main population It may not be possible to calculate the age specific death rates for the sub section but it is possible to infer from a comparison of the observed number of deaths and the expected number derived from the age specific death rates of the main population whether or not those rates can be operating on the sub section In such circumstances the inference that the age specific rates operating on the sub-section are not the same as those operating on the main population can be linked with the attribute or attributes which distinguish the sub section from the main population and may prove of very great value Examples of such a situation are to be found in the study of occupational diseases (*e g* Registrar General 1958) and also of regional variations of the mortality within a country (*e g* Registrar General 1957) when it is often the case that the sub population under consideration is too small for the actual age specific death rates to be calculated

Where the base population is imaginary and there is therefore no observed number of deaths all the age standardized summarizing indices calculated must be derived from expected numbers and by definition the age specific death rates for each hypothetical situation are known Examination of the age specific death rates themselves will therefore answer the question whether they are or are not the same and nothing is to be gained by the use of a summarizing index for this purpose

I can therefore see little justification for the current widespread practice (*e g* Segi 1957 Segi Fujisaku and Kurihara 1957) of publishing long series of international disease specific death rate comparisons which use age standardizing indices only The reader is thereby deprived of the benefit of the information that was inherent in the age specific death rates which were necessarily calculated in order to obtain the indices

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4 Comparison of Mortality from Cancer of the Rectum in Selected Countries

Male and female age specific death rates from cancer of the rectum for the years 1951–55 have been calculated for all those countries previously studied by Case and Harley (1958) for which we were able to find suitable data in the library of the Registrar General for England Wales These rates for seventeen countries in addition to England and Wales are shown in Appendix Tables XXIV and XXV and the rates for age groups 35–39 to 80–84 years are presented in diagrammatic form for ease of comparison in Figures 6–24 (pp 19–28)

The method adopted for calculating these rates was to divide the sum of the deaths in each age group over the period 1951–55 by the sum of the population figures for that age group for the same period of years The aim was to cover ages 0–84 years in five year age groups and this was possible in most cases

The numbers of deaths from cancer of the rectum by age and sex were taken direct from the official publications of the countries concerned and where possible population figures were taken from the same sources Where suitable population figures were not published in conjunction with the death figures appropriate populations from some other reliable source were used and where detailed population figures for every year of the five year period could not be found use was made of such data as were available in order to arrive at a reasonable estimate

Death data for Germany and Norway were not available for all the five years and calculations were therefore based in these two cases on a four year period

For France and Japan population returns in five year age groups covering all ages up to 84 years could not be obtained The rates for France for age groups 75–79 and 80–84 and for the indeterminate group 85+ are for this reason based on data for the two years 1954 and 1955 and the rates for ages 80–84 and 85+ for Japan on the year 1955 only

Deaths from cancer of the rectum by five year age groups were not available beyond the age of 74 years for Israel and 79 years for Denmark calculations made above these ages for these two countries are not therefore comparable with those for the remaining countries

Reference

Case R A M & Harley Joyce L (1958) *Cancer Death Rates by Site Age and Sex 21 Selected Countries* 1951–53 London Institute of Cancer Research Royal Cancer Hospital

TABLE XXIV

Contemporary Arrays of Age specific Death Rates for Cancer of the Rectum (I S C No 154) in 18 Selected Countries 1951–55 Males

Age	Australia*	Canada †	Denmark	Finland	France	Germany ‡ (Fed Rep)	Ireland (Republic)	Israel (Jewish pop)	Italy
0—	0 000	0 001	0 000	0 000	0 000	0 000	0 000	0 000	0 001
5—	0 000	0 000	0 000	0 000	0 000	0 000	0 001	0 000	0 000
10—	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
15—	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 003	0·000
20—	0 001	0 001	0 000	0 000	0 000	0 001	0 004	0 000	0 001
25—	0 004	0 004	0 004	0 001	0 002	0 001	0 002	0·000	0 003
30—	0 004	0 007	0 004	0 005	0 004	0 004	0 008	0 014	0 004
35—	0 014	0 011	0 020	0 011	0 009	0 010	0 022	0·008	0 007
40—	0 022	0 022	0 042	0 009	0 019	0 019	0 026	0 014	0 012
45—	0 046	0 052	0 083	0 028	0 039	0 043	0 066	0 025	0 079
50—	0 074	0 116	0 144	0 041	0 087	0 080	0 123	0 068	0 056
55—	0 136	0 162	0 265	0 081	0 159	0 157	0 243	0 067	0 100
60—	0 241	0 286	0 433	0 167	0 274	0 299	0 320	0 129	0 165
65—	0 378	0 433	0 709	0 283	0 437	0 536	0 565	0 157	0 249
70—	0 544	0 622	1 250	0 475	0 602	0 789	0 843	0 585	0 339
75—	0 838	0 828	1 476	0 706	0 748§	1·070	0 986		0 414
80—	0 971	0 995	2 252	0 578	0 828§	1 211	0 969	0 924	0 373
85+	1 063	1 190		0 743	0 681§	1 087	1 131		0 313
All ages	0 068	0 078	0 160	0 037	0 088	0 104	0 120	0 033	0 041

Age specific death rates p r 1 000 living p r year

* Excluding full blood aboriginals
† Excluding Yukon and N W Territories
‡ 1952–55 only
§ 1954 and 1955 only

Age	Japan	Netherlands	New Zealand*	Norway†	Sweden	United Kingdom: England and Wales	United Kingdom: Northern Ireland	United Kingdom: Scotland	United States: Non whites	United States: Whites
0—	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
5—	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 000
10—	0 000	0 000	0 000	0 000	0 000	0 000	0 000	0 001	0 000	0 000
15—	0 000	0 000	0 000	0 000	0 000	0 001	0 000	0 001	0 000	0 001
20—	0 001	0 000	0 000	0 000	0 002	0 002	0 000	0 002	0 004	0 007
25—	0 003	0 002	0 000	0 000	0 002	0 004	0 009	0 012	0 006	0 003
30—	0 007	0 006	0 003	0 002	0 005	0 008	0 004	0 009	0 006	0 005
35—	0 014	0 014	0 015	0 006	0 010	0 017	0 019	0 026	0 015	0 017
40—	0 023	0 024	0 018	0 023	0 024	0 036	0·018	0 031	0 029	0 026
45—	0 036	0 038	0 037	0 019	0 035	0 064	0 040	0 067	0 052	0 050
50—	0 062	0 086	0 134	0 068	0 066	0 131	0 098	0 124	0 105	0 097
55—	0 110	0 139	0 173	0 102	0 133	0 234	0 177	0 234	0 147	0 170
60—	0 175	0 247	0 209	0 166	0 234	0 415	0 330	0 362	0 222	0·273
65—	0 267	0 403	0 490	0 268	0 379	0 701	0 707	0 612	0 336	0 431
70—	0 349	0 693	0 617	0 472	0 595	1·085	0 986	1·069	0 349	0 552
75—	0 389	1 034	0 702	0 573	0 749	1 639	1·082	1 448	0 410	0 740
80—	0 379‡	1 446	1 421	0 766	0 982	1 976	1 244	1 734	0 430	0 914
85+	0 328‡	1 533	1 489	0 819	1 131	1 924	1 332	1 317	0·316	0·960
All ages	0 030	0 084	0 088	0·061	0 088	0 158	0 116	0 137	0·043	0 050

Age specific death rates p r 1,000 living per year

* Excluding Maoris
† 1951–54 only
‡ 1955 only

TABLE XXV

Contemporary Arrays of Age specific Death Rates for Cancer of the Rectum (I S C No 154) in 18 Selected Countries 1951–55 Females

Age	*Australia**	*Canada †*	*Denmark*	*Finland*	*France*	*Germany‡ (Fed Rep)*	*Ireland (Republic)*	*Israel (Jewish pop)*	*Italy*
0–	0·000	0·000	0·001	0·000	0·000	0·000	0·000	0·000	0·000
5–	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
10–	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
15–	0·001	0·001	0·000	0·000	0·000	0·000	0·002	0·000	0·001
20–	0·000	0·001	0·001	0·001	0·001	0·000	0·000	0·007	0·001
25–	0·005	0·003	0·005	0·003	0·001	0·002	0·000	0·000	0·002
30–	0·005	0·008	0·007	0·013	0·003	0·005	0·008	0·007	0·005
35–	0·013	0·016	0·005	0·011	0·010	0·012	0·012	0·008	0·008
40–	0·022	0·027	0·044	0·008	0·019	0·021	0·023	0·025	0·020
45–	0·040	0·051	0·050	0·026	0·029	0·040	0·048	0·056	0·028
50–	0·049	0·078	0·103	0·058	0·061	0·074	0·097	0·068	0·044
55–	0·092	0·112	0·174	0·101	0·097	0·115	0·085	0·049	0·075
60–	0·118	0·187	0·261	0·128	0·148	0·182	0·184	0·074	0·100
65–	0·205	0·239	0·323	0·171	0·228	0·253	0·247	0·190	0·149
70–	0·336	0·352	0·576	0·295	0·300	0·378	0·290	0·341	0·211
75–	0·447	0·431	0·749	0·433	0·420§	0·480	0·401	}	0·258
80–	0·537	0·649	} 1·083	0·729	0·495§	0·577	0·604	} 0·285	0·303
85+	0·540	0·741	}	0·538	0·441§	0·512	0·410	}	0·302
All ages	0·048	0·050	0·094	0·043	0·068	0·066	0·060	0·026	0·033

Age specific death rates per 1 000 living per year

* Excluding full blood aboriginals † Excluding Yukon and N W Territories
‡ 1952–55 only § 1954 and 1955 only

Age	*Japan*	*Netherlands*	*New Zealand**	*Norway†*	*Sweden*	*United Kingdom*			*United States*	
						England and Wales	*Northern Ireland*	*Scotland*	*Non whites*	*Whites*
0–	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·001	0·000
5–	0·000	0·000	0·000	0·000	0·001	0·000	0·000	0·000	0·000	0·000
10–	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000	0·000
15–	0·000	0·000	0·000	0·000	0·000	0·000	0·004	0·000	0·001	0·000
20–	0·001	0·001	0·000	0·000	0·003	0·002	0·000	0·001	0·003	0·001
25–	0·002	0·001	0·003	0·000	0·007	0·003	0·004	0·007	0·003	0·002
30–	0·007	0·006	0·003	0·007	0·005	0·009	0·004	0·013	0·009	0·006
35–	0·014	0·013	0·015	0·012	0·008	0·015	0·022	0·018	0·020	0·013
40–	0·025	0·028	0·028	0·002	0·017	0·035	0·026	0·028	0·040	0·025
45–	0·039	0·037	0·035	0·033	0·037	0·056	0·075	0·062	0·059	0·044
50–	0·065	0·070	0·089	0·050	0·065	0·096	0·089	0·089	0·118	0·075
55–	0·096	0·121	0·069	0·078	0·076	0·149	0·155	0·134	0·146	0·120
60–	0·133	0·182	0·195	0·108	0·125	0·236	0·138	0·205	0·193	0·177
65–	0·183	0·271	0·265	0·179	0·252	0·321	0·230	0·301	0·274	0·256
70–	0·217	0·408	0·370	0·248	0·306	0·480	0·380	0·462	0·221	0·324
75–	0·239	0·563	0·526	0·223	0·440	0·682	0·458	0·535	0·281	0·432
80–	0·256‡	0·837	1·033	0·525	0·460	0·900	0·629	0·754	0·309	[illegible]
85+	0·182‡	1·058	0·988	0·386	0·582	0·987	0·748	0·650	0·300	0·771
All ages	0·027	0·061	0·067	0·044	0·060	0·106	0·068	0·083	0·039	[illegible]

Age specific death rates per 1 000 living per year

* Excluding Maoris † 1951–54 only ‡ 1955 only

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